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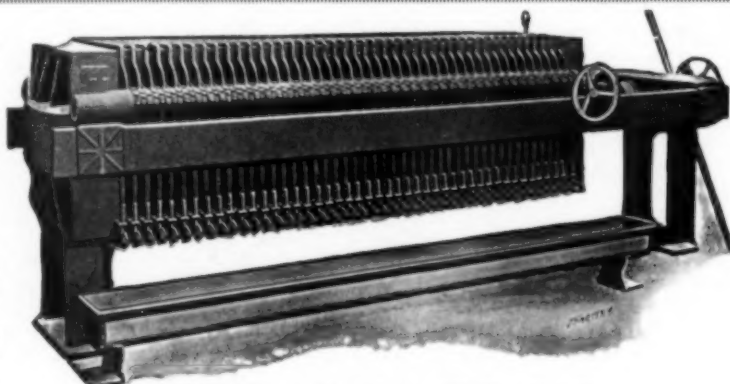
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Are You a Good American?

EACH good American wants to do his share toward winning the war. If he may not fight or engage in the various forms of war work over there, he wants naturally to have the feeling that he is working for his country here. Through the purchase of Liberty Bonds of the Fourth Liberty Loan, now at hand, the opportunity for just that form of service is given to all.

Whatever the occupation by which one earns his living, it can be turned into war work by way of Liberty Bonds. However indirect its connection with the prosecution of the war may seem, the connection can be made a direct one, if it contributes to the lending of money to the Government. Work produces capital, that is, an accumulation of goods, material riches, results from the daily labor of America. Capital is needed to carry the war to its end. A little taken from the gains of each worker, and set aside for bonds, will make the individual a direct participant in the country's war activities.

No one should miss the opportunity. No loyal citizen, anxious to help defend the United States against the aggression of the enemy, will miss it. Just a little saving, slight self-denial, a cutting off of some of the frills and luxuries of life to which good wages and nation-wide prosperity have accustomed us, will make it possible for every one to lend money to the Government. The widest possible distribution of the Fourth Liberty Loan is desirable on many counts. In the first place, it is the soundest kind of financing to spread securities broadcast. It enlists the active interest of all who buy them for the purpose for which they are issued. Then again, the more people there are who buy these bonds, the more people there are who have thus signified to Germany their intention to work unceasingly for victory. That is the spirit—the national will to win—which even the German people can understand.

If we all buy bonds, we can say to the soldiers who return at the end of the war, "We did our part at home while you were doing yours abroad. Together, we won the war and preserved America."

Lack of Life in the Rubber Section

THE proceedings of the Rubber Section of the American Chemical Society at its Cleveland meeting were unimportant. Substantially no new information was given out and while problems discussed were of considerable weight, no valuable decisions were reached. The trouble with this section is that most of those who attend its meetings are ready and anxious to

get valuable information but are unwilling to disclose anything of much worth. Many of the gentlemen present could have added to the store of knowledge without difficulty and without real injury to the interests they represented, but they remained silent owing to the mediæval attitude of most of the rubber companies.

It does beat all how slow we Americans are to learn that you can't get something for nothing. The business is thriving while rubber is scarce. Every improvement in technique that is introduced is of benefit to the industry at large, and while competitors are expected to compete, they are all in the same boat and they constitute the American rubber industry. There is nothing in the Sherman law to hinder them from co-operation in scientific development, and unless they work together in this respect they are likely to fall behind. The market for crude rubber is open to all civilization and the country that works it up to the best effect will get the trade. Great strides have been made but there is very much to be done still.

It comes to us on the authority of the *Chemical Engineer* of London that Professor Duisberg, of malodorous memory to those who recall the Eighth International Congress of Applied Chemistry, has developed in the Bayer Works in Germany the manufacture of synthetic rubber (methyl rubber) to a present extent of 150 metric tons per month. For several months they have been turning this out and in the meantime they have constructed larger works at Leverkusen with a capacity of 2000 tons annually. The quality is said to be inferior to natural gum but it answers the purpose of helping the Huns. If a similar advance has been made in this country it remains a secret, and we are skeptical enough to believe that it has not been attained.

The Rubber Section of the American Chemical Society needs a good jolt. It should organize itself into a Rubber Institute and get busy. It will not do the industry any harm for the various manufacturers to permit information to be contributed to the common cause; even then they will not know too much. There remains such a vast deal of work to be done that it is unprofitable to sit tight on secrets.

Jealousy Among the Mighty

JEALOUSY is one of the yellowest of human attributes and is not confined to the meek and lowly. On the contrary it aims for the high spots and very often it strikes them. It is the most useful tool of the High Command of the German Foreign Office and for years German agents have been actively fomenting it and encouraging it wherever the voice of the German All-Highest does not sound like the Voice of Divinity.

Some faults we are likely to outgrow as the years press upon us. We are less likely to flare up and shout and make offensive noises in speech than in our salad days. If we find our efforts frustrated, no matter how good the cause may be, we are likely to want to cripple the frustrator or, let us say, the instigator of our whilom inconvenience—when we are all frank and twenty. Speaking conservatively, we are ready to cut his heart out, to tear him limb from limb, to parcel his person for general distribution. With greater maturity we are disposed to address ourselves to overcoming the

difficulties of the task in hand rather than to tear around like a tiger. But jealousy clings on, and there is not one of us, no matter how exalted his position, who is not likely to be touched by it. The colonel of a regiment is rather the natural prey of the passion than the youngest subaltern, and a general is more likely to have occasion for jealousy than a colonel.

It is not many years ago that captains of industry functioned as our minor deities, and the petty jealousies which reigned on the Olympia of Wealth became so widely known that they were recognized along with traditional mothers-in-law, goats, Limburger cheese, tomato cans and other time-honored objects as a source of humor.

But now we are at war and jealousy among the mighty is not funny at all; it is no funnier than treason. Once in a while we come across the evidences of it in high places and it takes more than a little patience to be perfectly good and quiet about it. The only safe thing is to engage in a little earnest meditation every time an important decision is reached. If there is any possibility that jealousy has played a part in reaching a conclusion, the whole subject should be taken up *de novo* in order to banish the poison. If two men are working at the same task and one gets ahead of the other, that is a reasonable cause in these days for congratulation and nothing less, because the work is the sooner completed. We are at war and time is everything. There is not one of us too big to be jealous, and some delays—although far from all of them—can be attributed to no other source.

If we were only conscious of jealousy when it begins to confuse us and make us defective it would not be so dangerous; but as a rule the subject of the trouble is the last one to learn of it. And everybody denies it. On the other hand, there is not a man of responsibility who should not constantly hold himself on guard against it. It is a serious danger. It has frustrated more in the way of achievement than stupidity itself.

Talking Too Much At the Wrong Time

THE chemical exposition serves the excellent purpose of distributing information among loyal Americans, but we are sometimes disposed to forget that enemy aliens can read, write and cipher. They can also make intelligent observations, and there are thousands of ways to get their information over the lines from Holland, Sweden, Norway and Denmark. Enemy aliens do not wear special uniforms or insignia of any sort, and they do not all speak with a German accent. They are not all herded in concentration camps and they are very active when they are at large.

Chemists engaged in industry are likely to be secretive about their own work. We do not hesitate to criticize this as a fault, more particularly in the short-sighted administrative men who, having the power, forbid them to speak and give out anything but urge them to listen and get something if they can. On the other hand, being pressed and squeezed with secrecy in respect to their own work, they are likely to be gossips about that of others. In fact, scientific men are said to be rather talkative among themselves. This is all as it should be; indeed, we are, ourselves, purveyors of sci-

tific news, and we should be in a bad way if our friends were to lose their curiosity. And we are not charging our friends with indiscretions in speech. We merely know that indiscretions have occurred somewhere, and our present purpose is to caution chemists and engineers as well as to take it to heart ourselves.

We are in the midst of war and the lid is off. It is the nastiest, dirtiest war that ever was fought. There seems to be no bottom to the German's depravity and no portal to his mind save that which may be discovered by his own methods. Therefore with such devices as poison gas in general use, it stands to reason that the only value to some of these outrageous man-killing things is to be there, to paraphrase the late General Forrest, the firstest with the mostest devilment. There is no advantage when both sides employ the same novelties in munitions; the advantage lasts only as long as one side has it and the other has not.

We have been amazed to hear a lot of loose talk going on in regard to what is about to be done, and concerning many inventions in proposed warfare of which the enemy should know nothing. We learned the other day of the almost public congratulations offered to an inventor who had invented an instrument that might be of signal advantage for not over a week, after which the enemy would doubtless prepare himself in a similar manner. The greatest possible secrecy had been observed and yet here was the subject made common gossip, and very likely known at German headquarters by this time.

There is only one thing to do about details of novelties in munitions or chemical or any other kind of warfare that may be under advisement but not yet introduced at the front, and that is to shut up, tight, no matter what we hear. There will be plenty of opportunity to talk about such things after the war.

Basic Eight-Hour Day in Steel Industry

THE action of the United States Steel Corporation in deciding to establish "the basic eight-hour day" in its plants doubtless means general adoption by the iron and steel industry. An outstanding feature of the decision is that it was reached without any suggestion in that direction by the National War Labor Board. It is related, indeed, that at least a twelvemonth ago there were several operating heads of Steel Corporation subsidiaries who favored the adoption of the basic eight-hour day at that time.

This is a war-time measure in a double sense. On the one hand, it is a long step in the direction of encouraging maximum effort on the part of employees. The workmen will not be disposed to seek shorter hours when they are being paid time and a half for the hours per day in excess of eight, and that means just so much labor kept in the American war machine. On the other hand, the eight-hour day was destined eventually to become quite general in the industry, for the twelve-hour day could not continue indefinitely, and much of the work must perforce be divided into either twelve-hour or eight-hour shifts. If the eight-hour principle were to be adopted at some time, war-time with its attendant dislocations, is a better time than ordinary peace times, when the necessary arrangements would be much more difficult. At some time after the war, perhaps soon,

perhaps far distant, the labor supply will be such as to make feasible or even to dictate, the establishment of eight hours as the day's work, and the change will take the logical form of dispensing with overtime work, with its attendant money bonus. Such a change may still be somewhat difficult, but it will not be as difficult as if the basic eight-hour day principle had not been introduced as a stepping stone.

As the iron and steel industry was organized—or rather unorganized—before the war the introduction of a three-shift system in work where a two-shift system prevails could not have been accomplished with no change in the rate of pay per shift, because an increased wage-cost of 50 per cent would have been involved, and competitive conditions stood as a barrier. The money cost of introducing the basic eight-hour day, on the other hand, is almost insignificant as such matters go now. It means 16½ per cent advance in the day's pay for 12-hour men, and 10 per cent advance for 10-hour men. Some other adjustments may be required for men working less than 12 hours, but the total payroll increase to all employees is not likely to be as much as 10 per cent. In comparison with this, there is the record that during 1916 there were three 10 per cent wage advances in the iron and steel industry, in 1917 two 10 per cent advances, and already this year a 15 per cent advance and a 10 per cent advance, making a total war record of seven wage advances. The eighth is now that involved in the introduction of the basic eight-hour day. The seven advances had approximately doubled wages.

There has been no ground for assuming that after the war the iron and steel industry's wages would either remain at the war-time level or would decline to the pre-war level. Some intermediate ground would be found. In this new alignment the ground will be found at a higher level, in terms of rates per hour, than would otherwise have been the case. The amount of the industry's readjustment, in costs and selling prices, is correspondingly reduced, and that is certainly not disadvantageous.

Within a very considerable number of years, at least, steel will not be nearly as cheap as it was before the war. That will not be altogether an evil. The war has taught men much as to the intrinsic value of materials. Food material, for instance, is on all hands regarded with much more respect than formerly. It is made to go farther, and so with clothing, lumber, practically everything. Steel must be made stronger. If it used to cost 10 per cent of the price to make it 20 per cent stronger it will not cost as much as 10 per cent of the new price, with its higher basis, to make the increase in strength. There was a time when Mesabi ore was mined as cheap as dirt, and transported a thousand miles, by rail, water and rail, for \$2 a ton, other operations being in proportion, and tons of steel were almost no consideration in making a structure strong. In future steel will be made and used more carefully.

These changes enlarge the field of the metallurgist and engineer. There is a fresh demand created upon the metallurgist to improve the quality of steel and upon the engineer to save labor. Jobs that were not the province of labor-saving devices are made so. The production of steel must become still more nearly automatic.

Readers' Views and Comments

Synthetic Phenol

To the Editor of Chemical & Metallurgical Engineering

Sir:—The recent article by Mr. A. G. Peterkin, describing the Dennis Bull synthetic phenol process is very interesting to manufacturers, but the advantages which it is said to offer are open to question.

The value of any process depends largely on the way in which it can be linked with other lines of manufacture to produce or to utilize by-products. It does not usually pay to operate a recovery plant when the by-products can be sold, and where the investment, needed for the recovery plant, could be used for direct manufacture.

The demand for chlorine and its products has kept pace with, and is now even more urgent than that for caustic, and promises at present to continue so indefinitely. The demand for sulphite of soda, and other salts requiring carbonate of soda or its equivalent, is now so great that it would be a mistake to convert it into caustic.

For producing phenol to the best advantage in the United States, a plant should be located where cheap coal and electricity are available, far enough West for a cheap acid and salt, but yet within reach of the market for soda and chlorine products. It would be operated in connection with an electrolytic caustic and chlorine plant, and a contact acid plant able to compete with the zinc by-product. The by-product soda would be used for making sulphite, bisulphite, sulphide, hypsulphite, chlorate, phosphate, or other such salts.

In comparing the processes it should be taken for granted that they are operated with equal skill and all losses, including those due to shipping, storing, and handling should be included in the figures. In the article, the figures given for raw material required are evidently based on the experience in the Barrett plant with the CO_2 acidification, and do not represent up-to-date practice with the "old" type of process as worked elsewhere.

The excess acid used in the sulphonation should not exceed 60 per cent of the weight of benzol sulphonated, and as there is 10 per cent excess required in the Barrett process, the actual saving is not over 50 per cent. To make this saving requires the handling of 50 times the weight of the sulphonic acid or 200 times this of benzol. As benzol is worth three times the cost of acid, the value of that used in the extraction is 600 times that of the acid to be saved, so a loss in handling of one-sixth of one per cent would offset the saving.

The figures for these losses are not given, but I doubt very much if, when all losses are included, the Barrett process as described can equal the 93 to 95 per cent over all yield now expected in the old process plants.

There is a net material saving shown in acid, lime, soda ash, steam for evaporation, labor, and plant costs, but the salt made contains an excessive amount of sulphate of soda and requires a considerable increase in the caustic needed in the fusion. This again increases

the volume of liquors in the acidification where the most serious losses of the process occur. The process should be modified to remove this impurity by a preliminary separation of the sulphate and the treatment of the resulting mixture of sulphate and sulphonate by the lime and soda process in the usual manner.

When this is done, and all losses figured, this part of the process may still show a saving, especially in a plant where benzol can be had at production cost, but acid and lime must be bought.

For the fusion, the choice of a liquid or dry salt is an old question, and the liquid has been frequently used. Experience shows that yields of over 90 per cent are exceedingly hard to maintain with either a liquid or dry salt, but that 95 per cent, with occasional fusions running 97 to 98 per cent can be obtained with a moist salt in proper condition. With such salt the capacity of drum dryers is very great, and the steam and labor required to run them is more than offset by the saving in time, and fuel in the fusion. The water must be evaporated somewhere, and it should be done where it is cheapest, and does not interfere with other work.

While the acidification by CO_2 presents no great difficulty to the experienced man, it has given a great deal of trouble in some plants where it has been tried and requires more skill than either acidification with sulphuric acid or SO_2 , and should not be considered for either a war-time plant or a permanent one, as the SO_2 obtained from the neutralization of the sulphonic acid with sodium sulphite supplies a large part of the acid required, and a sulphur burner worth a few hundred dollars can furnish all additional gas for a large plant. Of course, in an acid plant, gas from the ore burners is available. The sulphite produced by this is worth more than the caustic and there is a large increase in the weight.

One of the most serious difficulties of the acid and the CO_2 acidification is the tendency to form emulsions, if too concentrated solutions are used. To avoid trouble, the workmen dilute them to excess. Phenol is very soluble in a solution of phenate or of undecomposed salt, and as the bulk of the liquors is great, a small percentage of phenol in the liquor will represent 10 to 20 per cent of the total phenol. The statement is made that the liquor can be completely freed of phenol and a 4 per cent distillate obtained by distilling with steam. Experiment shows that the vaporization of phenol is a function of concentration and that there would still be phenol left, when the distillate showed 2 per cent, from a liquor containing 2 per cent, which would require the evaporation and condensation of about twenty tons of water per ton of phenol made.

Probably the best method of acidification is to use SO_2 only, and separate the sulphite as formed. The wet sulphite is saturated with SO_2 to complete the decomposition of any phenate, and then dried below 150 C. in a current of steam. Still residues and any sludge formed go in with the sulphite, and the phenol is re-

covered with practically no loss. The distillate and fore-run are used in the quenchers, with the liquor from previous batches. As no water is added except as steam, and there is considerable evaporation in the quenchers, there is no liquor to dispose of, and the sulphite is free from phenol, and in excellent condition for any other use. Owing to the comparatively small amount of water to be evaporated, the cost of the drying is small and it prevents accidental losses such as occur with liquors.

In the matter of labor, any difference would be more in the design of the plant than the process. Labor in most phenol plants at present is higher than it should be, because they were designed by men who did not yet know the essentials of the process and modern methods, and changes in an old plant are hard to make satisfactorily.

In regard to transportation, any statement which includes a movement of raw materials, but falls short of a complete analysis of movements of by-products, is apt to be misleading. In any case it depends on the location of the plant and the average distance of the market.

E. E. HOTSON.

An Outgo, Not an Income Tax

To the Editor of Chemical & Metallurgical Engineering

SIR:—The proposed new sumptuary tax bill before the Ways and Means Committee of the House of Representatives comprehends raising eight billion dollars annually by taxes on clothing of the more expensive grades; on jewelry, automobiles—in fact all luxuries and many necessities. If one of us pays more than \$2.50 for a hotel room, the state will impose a heavy tax, and so on. This tax is a tax on excess expenditure and is planned to inhibit all luxuries and to reduce to a minimum any waste of essentials. By its enforced economies it will go far towards paying the bill for the war, and in its nature, we think is to be preferred to any great increase in the income tax. For is not an outgo tax, stopping foolish consumption, better than an income tax which puts the brakes on production? The state should desire to stimulate incomes and to stop foolish outgo.

This new departure in taxation coming as it does after other new departures suggests the saying rife among sociologists some six years ago that "socialism not on Marxian lines but socialism by taxation is here." We doubt much if the policy of Government socialism by taxation endorsed and sponsored by the Democrats, the party of Jeffersonian simplicity and individualism, will become less marked in the decade following the end of the war, and we believe that the policy of taxing excess expenditures will be in vogue for years. As a tax on outgo rather than on income it stimulates a healthy growth of trade and industry and tends to conserve and stabilize wealth rather than to destroy and scatter it.

Now, these premises and propositions elucidate further the obvious fact that the country where justice, freedom and intelligence rule, will, after the war, be the best country to live in, for the Bolsheviki are not a cause but a result of graft, license and ignorance. Therefore, if the United States is to grow and flourish, if it is to retain its position as a refuge for the oppressed, retaining a capitalistic form of government and the rights

of property with this new Socialism by Taxation, it must have an intelligent government and an intelligent system of taxation. When this is attained capital and labor will harmonize and we can be exceedingly prosperous because of our industrial and psychological security and stability, and we can afford to pay large taxes.

Now this second set of premises and propositions suggests a further line of thought. If taxes be high, interest rates of course will be high, interest being the measure of the productivity of capital. If interest rates be high, capital must be fruitful and there is no better way for capital to fructify than in the chemical and metallurgical industry. Offhand, we can recall a metallurgical plant costing \$6,500 that with \$50,000 working capital made a profit of \$1,000 per day, and another costing \$175,000 that made \$750,000 per annum. While these are startling exceptions, they only prove the rule that by intelligently directed scientific work capital can be made most productive in the chemical and metallurgical industry. Since it does not seem entirely fanciful to believe that after the war the normal rate of interest may be as high as one per cent a month—the actual legal rate at Rome for centuries, when that great empire flourished under the *Pax Romana*—we incline to the opinion that the future high rates of interest will force an enormous growth of applied chemistry. Granting a well and intelligently managed system of government that induces a feeling of peace and security, capital will increase correspondingly fast. And one sign of intelligence in government is a tax on outgo, not on income, such as now emanates from Washington.

"CHEMIST."

Research Preparedness in the Zinc Industry

To the Editor of Chemical & Metallurgical Engineering.

SIR:—The letter of Mr. Eric John Ericson in your issue of August 15, takes issue as to my attitude towards the value of the sulphuric acid industry as a corollary to spelter manufacture.

My attitude is that while the acid corollary may show on paper in normal times a value of a dollar or two a ton of zinc ore, and does in war times show a value perhaps exceeding \$5 per ton, the manufacture is attended with increasing costs of roasting due to the type of fine burners necessary and the character of flotation slimes used as feed, yielding an abnormal degree of dust in flues and chambers. This coupled with fuel and labor costs is perhaps going to change the balance-sheet after the war.

Again I felt that the freight upon the acid to market was a serious item and often decided the location of a zinc smelter and this involved freights on zinc ore.

I spoke in very broad terms, looking ahead and realizing that the zinc industry was about to see radical changes in metallurgical and economic practice. While zinc distillation in modernized form will still continue to be practised near population centres, and thus have a sale for acid, the reason for such location will be because of the market for domestic briquet fuel which will constitute the most valuable corollary in connection with zinc distillation, because it alone will reduce the fuel costs to the lowest figure, which condition will be necessary to meet the coming heavy competition of cheap water power and cheap zinc by-product concentrates in the northwest.

PARKER C. CHOATE.

Western Chemical and Metallurgical Field

Great Falls Rod Mill Commences Operations

A NOTEWORTHY event in the progress of Western metal manufacturing occurred early in June, when the new rod mill of the Anaconda Copper Mining Company started operations. This mill is erected at the Great Falls plant on the high ground north-east of the big stack, and is designed for a capacity of 100 tons of copper rods per shift of eight hours. When operating three shifts, the plant may reasonably be expected to maintain a production of 250 tons of finished material daily. At present only one shift is in operation, its output being rods about 0.4 inch in diameter, which are being reeled and stored awaiting completion of the die benches. Partial operation was thus inaugurated six weeks before expectations; complete operations will be instituted within a very short time.

The mill is equipped with a Rockwell heating furnace designed for oil- or coal-firing. The roughing rolls take the regular 4-inch wire bar through nine passes, delivering to a stand of intermediate rolls next in train. At the present time three passes through these intermediate rolls are used to reduce the rod to 0.4 inch. Finishing rolls directly alongside will make sizes from this down to about $\frac{1}{4}$ inch.

Other equipment about ready for operation consists of a 4-die machine for special sizes and shapes, a 4-die machine for trolley wire, two 10-die machines for small wires, and four stranding machines for making cables, together with the necessary auxiliaries such as pickling tubs, bright-annealing furnace, and brazing furnace. It is expected that the plant will produce a good proportion of the trolley wire and bonds required for present and future western railway electrifications, together with important quantities of copper products for the general electrical and jobbing houses that are located in this region.

Potash in 1917

THE United States production of potash bearing materials during 1917 is reported in a recent statement from the United States Geological Survey. Three times as much was reported as in the preceding year—it amounted to 126,577 tons of material, containing an average of 26.4 per cent K_2O , representing 32,366 tons of pure potash, which is practically the amount predicted at the middle of the year by Hoyt S. Gale of the Survey. The average selling price at the points of production was \$4.26 per unit—that is to say, 21.3 cents per pound of K_2O —making the value of the potash produced during 1917 equal to \$13,791,922. The quantity produced is about 13 per cent of the normal consumption of the country prior to the war, and while it is far from adequate, still the most insistent demands can now be met.

The Nebraska lakes produced nearly half of the entire output, shipping in the neighborhood of 14,500 tons of pure potash. However, this is hardly half the potential production of the plants operating in that field at the end of the year. The discrepancy is an indication of the rapid expansion of the industry. Much of the capacity was not ready for operation before the year was nearly gone. It is a further indication of the

extreme difficulty in the labor, fuel, and equipment supply and the transportation situation.

The potash produced from kelp represents about ten per cent of the total. A large part of this was high-grade potassium chloride, and the balance was kelp char containing 16 to 36 per cent of water-soluble potash. An unexpected shortage on the kelp crop curtailed the production from this source.

The production from alunite was disappointing, but bids fair to be largely augmented in 1918. This is also true for potash from cement plants. In the latter case, eight mills reported a production of 13,582 tons of dust containing 1621 tons of K_2O . Installations for the recovery of this fertilizing material as a byproduct of cement kilns are going in apace, and it is expected that the output for the current year will be second only to the production from brines. Such plants are particularly desirable, since they recover the material at such a slight cost that they can continue in operation when the selling price of the material has dropped to a very low level.

Minor amounts of potash were recovered from the residue of charred molasses wasted from alcohol distilleries, the waste liquors from beet-sugar manufacturing, and from the stoves and dust catchers at iron blast furnaces. Crude potash is still produced by a number of small operators by the old methods of leaching hardwood ashes. Thirty-six producers, chiefly in Wisconsin and Michigan marketed about 700 tons of material, estimated to contain about 424 tons of K_2O . Wool washings and organic wastes from several other manufacturing plants also added their quota to the total.

The Portland Gold Mining Company.—The Independence Mill was completed about the middle of the past year, being considerably delayed by slow deliveries, at a cost considerably greater than originally estimated. It has been operated continuously since completion and is gradually approaching the expected capacity of 42,000 tons per month. The cost of treating low grade ore at this mill at prices current eighteen months ago, would be materially less than expected when the mill was designed, and consequently it will form a very profitable asset to the company on the return of normal price levels. During the past year 592,995 tons of crude ore and waste were mined and handled. After sorting, this yielded 75,542 tons of shipping ore sent to Colorado Springs, which gave a gross return of \$1,617,406.62 or \$21.40 per ton. The Victor mill handled reject, mill dirt from stopes and development work, and dump ore totalling 236,915 tons, with average values of \$1.762. The Independence mill handled reject and dump ore totalling 236,915 tons, with average values of \$1.762. The net cost of mining and milling amounted to \$1,864,265.61, and the net profits of the company for the past year, as far as mining and milling operations are concerned, were \$666,254.42 (\$768,809.84 in 1916). The mine manager, Mr. F. L. SMALE, makes some interesting observations on the labor situation in the district, as follows: "Early in the year the effects of the war were noticeable in the labor situation, our best miners quietly leaving the district and going to other camps where special inducements were offered for skilled men. This condition has continued, notwithstanding a wage increase that was asked for and granted."

Cleveland Meeting of the American Chemical Society

Important Actions by the Council—Large Attendance at Technical Sessions—Successful Symposia on Dyestuffs and Potash—Social Features

THE annual meeting of the American Chemical Society was held at Cleveland on Sept. 9 to 13. The attendance was larger than was expected, the registration list showing nearly 600 members. At 4 p.m. the Council met at the University Club. In the absence of the president, DR. W. H. NICHOLS, who was detained at home by an injury to his knee, the senior vice-president, Dr. H. S. MINER, presided. The several vice-presidents are also respectively chairmen of the various divisions and their rank accords with their seniority as members of the society.

COUNCIL MEETING

It was reported that the chemical census which is being prepared in coöperation with the Bureau of Foreign and Domestic Commerce will be ready for the printer about December 1 and that it should be ready for distribution about February 1, 1919, at the price of 30c. per copy. Further details regarding this census and other statistics on the chemical industry have already been published.

The editors of the various journals were re-elected as were also the retiring members of advisory committees. In the evening the Council were guests of the University Club at dinner.

PROMINENT GERMAN CHEMISTS DROPPED FROM ROLL

On Tuesday morning the general meeting was called to order by Vice-President MINER at Hotel Statler at 10 a.m. There was presented from the Council the following preamble and resolution which were unanimously adopted:

WHEREAS the behavior in war of the German people has dishonored them among the enlightened nations of the earth and proved them unfit to associate with civilized men and women, and

WHEREAS Walther Nernst, Wilhelm Ostwald and Emil Fischer have been actively associated with the German Government and its people in their conduct and offenses, now therefore be it

RESOLVED that the said Nernst, Ostwald and Fischer be dropped from the rolls as honorary members of the American Chemical Society and that this act be construed to take effect as of August 1, 1914.

THE CHEMISTS' PLACE IN WARFARE

Professor A. W. SMITH of the Case School of Applied Science made an address of welcome, which was responded to by Vice-President Miner. The Secretary, Dr. CHARLES L. PARSONS, read a paper on The American Chemists' Place in Warfare. He related that toward the end of 1916 he made a trip on behalf of the United States Government to England, France and Italy and that in all these countries complaints were persistent of their loss of chemists and technically trained men, and

that at the time of his visit each of these countries had withdrawn her chemists from the line.

In order to provide as far as possible against scientific and technical inadequacy in this country, the American Chemical Society, through its President Dr. Julius Stieglitz, offered the services and facilities of the Society to the President of the United States, shortly after war was declared. Following this, the Bureau of Mines in coöperation with the Society, prepared a census of the chemists of the country, beginning in February 1917. Over 17,000 chemists have sent their records, qualifications, age, etc., to Secretary Parsons in reply. Additions are being constantly made to this list. Over 50,000 circular letters and 10,000 personal letters have been forwarded from Washington in the correspondence which the census entailed.

The intensity of the need for chemists was noted as soon as the war began and this increases as time goes on. Over 700 with 1100 helpers are engaged in Washington in one government laboratory on gas work alone, and branch laboratories have been established at Johns Hopkins, Harvard, Yale, the Catholic University of Washington, Bryn Mawr, many state universities and in a considerable number of manufacturing establishments. In June 1919 the work was transferred to the War Department. In the meantime the medical, ordnance and other departments have called for more chemists, and the number has been materially increased. The staff is now so organized that assignments are made as needed. The authorized personnel of the Chemical Warfare Service is 45,000 of which a much smaller number are chemists.

Mr. CHARLES H. MCDOWELL read a paper on The Work in the Chemical Section of the War Industries Board. He said that the main difficulty with the United States was that it had been called upon to start big business at the top. This had often entailed loss and expense which only time could have avoided; and there was no time. It is evident, he held, that if the war continues much longer the production of certain materials for the open market must be curtailed, which calls for sacrifices from industries as well as of materials. The unanimity with which leaders of industry have met the demands of war, without complaint and in entire willingness calls for the greatest praise. The Board has 18 sections, and representatives of these meet every morning with the chiefs of buying commissions for the Allies as well as with representatives of the U. S. War and Navy departments to consider what it wanted and where and how it may be obtained. The Board itself does no direct buying but it fixes prices to be paid for staple products.

Certain parts of the country are now over-burdened with war contracts. For instance the district between Altoona, Pa., and Norfolk, Va., is now at its maximum economic capacity and no new contracts or new in-

stalations can be encouraged in this district. The steel situation, said Mr. McDowell, is desperate. There is practically no structural steel that can be produced. Even Government buildings must be erected without it. Dr. Weidlein, acting director of the Mellon Institute and Dr. Moody of the College of The City of New York are among the Board's consultants and the research facilities of the Mellon Institute of Pittsburgh have been placed at its disposal.

DR. GRINNELL JONES, chemist of the Tariff Commission delivered an address on War Disturbances and Peace Readjustments in the Chemical Industries². He said the greatest changes have been wrought in the chemical and metal working industries, and that the Tariff Commission is actively engaged in studying the situations.

CHEMISTRY AND SHIPPING

Ships are no longer permitted to seek the most profitable cargoes. The War Board determines what may be brought in and what may not. The advisory chemist on the staff of the War Board is DR. PENNIMAN of Baltimore. An example of something supposed to be needed but finally prohibited is tapioca. Aside from the familiar pudding it was needed for its starch to make gum for postage stamps and nitro-starch, which is now one of the safest explosives. The Post Office Department soon discovered a substitute and after rapid but intensive research, it was found that nitro-starch may be made from cornstarch—which theretofore was utterly impossible—and that the resultant product is better in quality and cheaper to make than from tapioca starch. And the avoidance of importing tapioca provides shipping to carry over and to supply 25,000 men.

There is a great diversion of materials from their normal use into war needs. Thus the fertilizer industry suffers not only from lack of potash, but from nitric and sulphuric acids and ammonia as well. Peace conditions should make great changes in fertilizer production. And he emphasized the fact that the *status quo ante* cannot be re-established in chemical industry.

GAS WARFARE RESEARCH

LIEUT.-COL. WILDER D. BANCROFT of the Chemical Warfare Service spoke on "Chemical Warfare Research." It had to do with the great research laboratory for gas service which was established one and a half years ago by the Bureau of Mines and taken over by the War Department on July 1 last. He gave an outline of the general procedure in regard to any given war gas. If a gas is offered as something new it must have certain qualities to receive thorough attention. The substance may be gaseous, liquid or solid, but it must be poisonous, or produce tears to excess or cause nausea or sneezing or it may produce a nose-twisting stench or it may be a smoke with obscuring power. It must be "good" of its class. One milligram per liter must kill a dog in 30 minutes, and if it is a lachrymatory substance it must be effective in dilutions of one one-hundredth of a milligram per liter. The raw material to make it must be available and easy to produce. There should be already established a good method of manufacture, but if the product itself has sufficient merit of wickedness, it is taken up and manufactured even if the only available method be wasteful. It all depends upon

how useful it may be. It must also be fairly stable. The Allies can use material within one to two months after a shell is loaded but our limits against polymerization are of necessity more rigid than those of the British, French or Italians.

The method of procedure, whether the gas be used by the Germans or developed by the Allies or only suggested and considered, is the same. The first step is for the Offense Division to make it. If it is solid it goes to the Dispersoid Division—and we cannot resist a note in appreciation of Professor Bancroft's happy invention of the name of this division. What the Dispersoid Division does with a solid poison gas is explained in true chemical fashion. Then it goes to the Toxicological Section where its degree of toxicity is determined and other properties are observed and recorded. If these reports are favorable it goes back to the Offense Research Laboratory where the best method of production is worked out and then to the Chemical Production Section where it is made in lots of from 50 lb. to one ton. At this point large-scale production may begin either by the Government or it may be assigned to some manufacturer for quantity production.

GASES STUDIED BY MANY SECTIONS

In the meantime samples of it have been making the rounds of other laboratories. The Analytical Section (which may have been the first to investigate it if it is a German product) determines the purity and the amounts of it contained in air under given conditions and here also tests are made of its behavior with other materials in canisters. The Pyrotechnic Section determines its stability when fired in shells and the Defense Research Section determines whether new substances must be put into the canisters with it and if so, what they are. It also takes up methods of detection and it many have to develop protective ointments to be used against blisters, etc., which it may cause. The Mechanical Research Section discovers if, with the change in the ingredients of the canister, the type of the canister must be changed. In the laboratory of the Pharmacological Section the general symptoms of its effects are studied and the problem of susceptibility is investigated. It is also the somewhat delicate business of this section to keep especially susceptible men out of the factories in which it is made. The Pathological Section studies in detail the manner in which various organs are attacked by it, while in the Therapeutic Section the task is undertaken to find effective methods of treating gassed men.

Every section reports twice a month, and a vast amount of reports is piling up. These reports go immediately to the Editorial Section in charge of Col. Bancroft. Here they are condensed and incorporated into semi-monthly reports which go to a selected list of persons in America and abroad. Monographs are in process on each subject which contains everything that is known about it, not only from the results of study here but also from the literature and from contributions made from abroad, as well as from captured German reports.

The whole system of the laboratories at the American University, as it is called, is described as very flexible so that each member of the staff may function wherever he is most urgently needed.

²Published in this journal, Sept. 24, 1918.

UNIVERSITIES AND CHEMICAL WAR WORK

PROFESSOR EDWARD W. WASHBURN, professor of ceramic chemistry at University of Illinois, but now of the National Research Council, read a paper on The Place of the University in Chemical War Work. He said the U. S. Government will need a great many chemists beyond those now employed and in excess of the normal output of colleges. The source of additional supply is expected to be the Student Army Training Corps. For this purpose the Government will undertake to train recruits of 18 years of age in three grades for the purpose. The method offers the most remarkable opportunity to any young man eligible for war service who is 18 years old and has passed his high school examinations. He may undertake any one of three courses in chemistry, i.e., the one-year, two-year or three-year course. He may go to any one of a number of colleges and study for four terms of 12 weeks each during one year. This will fit him to do routine analysis, and to be a laboratory assistant. The two-year course is designed to fit him for general chemical work in analysis, food, sanitary and technical work and to include the usual courses in chemical engineering. The three-year course is designed to prepare him for research. The study is very intensive and does not include the cultural studies outside of what the student may glean from science and mathematics, and some English in the three-year course. Every twelve weeks he must pass all examinations and no provision is made for failure. Nothing can be made up. If he fails to pass he is transferred to a cantonment for drill in whatever arm of the service men are needed. He receives \$30 a month pay and clothes, board and lodging. The fact is that more chemists are needed than are available and this has been decided upon as the best means for providing them.

The great need is for research. Much is done according to the best means at hand, and a great deal goes on merely because present methods will work. But many of them are far from the best possible methods. A large number are well worthy of scientific study and Dr. Washburn urged upon professors to undertake such problems in their laboratories where the high pressure of the government organizations does not prevail and to set aside their more favorite problems in research for the nonce. There is much to be done in the measurement of physical properties and the study of the chemical nature of materials that cannot be provided otherwise.

An interesting note is also that the U. S. Government now has scientific attachés assigned to the embassies of London, Paris and Rome. Professor Bumstead (physics) of Yale is attached to the embassy at London with a chemist in his staff. Professor W. F. Durand of Leland Stanford University is in Paris while Dr. H. S. Washington, Chemist of the Geological Survey is in Rome with Dr. Edgar Buckingham, a physicist, as his associate. The rank of scientific attachés is similar to those of the army and navy. They are appointed for the collection and distribution of scientific information in international relations. Their dispatches, like others, go by couriers.

DYESTUFF SYMPOSIUM

At 2 p.m. on Wednesday Sept. 10 the symposium on the chemistry of dyestuffs was held at Hotel Statler.

MR. R. NORRIS SHREVE of the Calco Chemical Co. presided, and in his introductory remarks he made an earnest plea for the prosecution of research. In no phase of applied chemistry are so many by-products developed as in the dye industry and these cannot be neglected. Uses must be found for them and the research laboratory is the only means of discovery. Another point was that American manufacturers have been trained to produce in bulk and to ignore those things which are only needed in small quantity. The function of those engaged in the industry is to supply needs as well as to earn dividends and while the profits on unusually demanded dyes may be negligible, the demand must be met either here or in Germany. Mr. Shreve proposed that the several organizations make each one a number of such products so that there may be the least duplication of effort in unprofitable enterprises and also that the greatest number of such materials be produced.

He urged upon manufacturers to look ahead as far as they can and declared that success would only abide with those who did so. He also emphasized the need of what we have been preaching for years, which is that in the body of final authority over a manufacturing establishment, whether it be its board of directors or its executive committee, there be found at least one member who has chemical understanding and training.

He concluded by announcing that the programs of a number of American dye manufacturers were considerably set aside in order to enable them to make munitions of war.

AMERICAN PROGRESS IN DYE MANUFACTURE

DR. L. J. MATOS of the National Aniline and Chemical Co. then spoke on America's Progress in Dyestuff Manufacture. He gave the following dates of the discovery of various coal-tar colors which succeeded the discovery of mauve by Perkin in 1856. Magenta was discovered in 1858; aniline black, 1862; nicholson blue, 1862; alizarine (by Perkin) in 1868; cachou de Laval, which was the first sulphur color, in 1873; methylene blue, 1877; azo reds, 1878; propiolic acid, from which followed synthetic indigo after many years, 1880; tartarazine, 1885; primuline, 1887; rhodamine, 1893; and sulphur black in 1895.

Until the outbreak of the war American dyes were at peace with the world, but when German colors were no longer available the troubles came. Makers had to get along with derivatives of benzene and naphthalene because toluene went into munitions and was worth upward of \$10 a gallon. And intermediates had been mostly imported from Germany. What was lacking to make them was the technical training and experience. The problems had to be attacked *de novo* and results, and at first yields, were seldom alike or satisfactory. Materials which had been bought in Germany 99.8 per cent pure were bought here which were 24 per cent, 33 per cent, 28 per cent and 50 per cent pure in successive shipments, the analysis of the last mentioned invoice reading "50 per cent H Acid and 50 per cent secondary products." So that some of the early dyes were off strength and off shade, and what secondary products were, no one could tell, because they were seldom twice alike. In taking up German patents very little enlightenment is discovered, because if, for instance, the product at a certain stage is one which it is practically

impossible to filter, the inventor's description in the patent is likely to read "I then filter"—and nothing more on the subject.

In the meantime great progress has been made. The yields have been brought up to good practice and impurities have been removed so that today there is no inferiority in American-made dyes. In strength and brilliancy of shade, they are, type for type, as good as those which were formerly imported. The company with which Dr. Matos is connected makes 69 different products. The general public is still debarred from the use of toluene which holds back the production of certain colors that are fast to light. These will come as soon as toluene may be used for this purpose instead of for TNT.

Of the 175 dyes now made in America, all are made from American raw materials and these include nearly all the types in use before the war. Among other dyes alizarine (Turkey red) is now produced in quantity sufficient to meet American requirement, and the speaker expressed the belief that the industry would be a permanent one.

THE TARIFF AND THE DYE INDUSTRY

DR. GRINNELL JONES, chemist of the U. S. Tariff Commission read a paper on The Production of American Dyes and Coal Tar Chemicals during 1917. The present tariff law on dyestuffs is short but it is none the less complex. It provides a duty of 15 per cent on intermediates and 30 per cent on dyes with a specific duty of 2½ cents per pound on intermediates and 5 cents per pound on dyes. Alizarine and indigo and certain allied materials are excepted from the specific duties. In regard to all other colors and intermediates there is a peculiar stipulation to the effect that after five years the duty on these shall decrease at the rate of 20 per cent per year provided the American production of dyes at that time is 60 per cent of those used in the country. If the country produces less than 60 per cent, the specific duty shall forthwith cease entirely. The critical date is in September 1921 so that it falls upon the Tariff Commission to have this information available at that time. To prepare for it they have reports from 190 manufacturers of whom 12 do not want their names published, chiefly on the ground that they make only for themselves or that they are about to discontinue and do not want to be bothered with inquiries. The Commission is preparing a pamphlet which will contain 178 names and the record of 12 anonymous manufacturers. The Geological Survey has taken the reports of the tar distillers and coke ovens and the pamphlet will also contain the output of crudes of the distillers and stripping plants. The total but not the individual production of materials will be given, except that in cases where the record of the total production would indicate the output of any single manufacturer, they will be omitted. There are 118 firms reporting on 134 different intermediates. The pamphlet will show 5,900,000 lb. beta naphthol and 10,000,000 lb. H-acid made in 1917; hardly any anthracene; the colors will prove to be mostly of the azo group and sulphur blacks, and 300,000 lb. indigo by one maker who was willing to have the figure printed. There were 260,000 lb. of photographic chemicals made. Of synthetic drugs there were made 900,000 lb. acetanilid U. S. P., and 500,000

lb. acetyl salicylic acid. Exclusive of clerks, sales force and others not engaged in manufacture there are 19,643 employees in dyestuff and allied industries of whom 1733 are chemists. The ratio of 8.8 per cent technically trained men is very high for any American industry.

DEVELOPMENTS SINCE 1914

DR. J. F. SCHOELLKOPF JR. of the War Industries Board was detained in Washington by official duties but his paper on The Development of the Dyestuff Industry since 1914 was read by Mr. Willard Watkins of the Schoellkopf branch of the National Aniline and Chemical Company. He believes that the problems to be met after the war will be far greater than during the war. The total production in the United States before the war was less than 6,000,000 lb. per year and owing to the nature of German competition the trade conditions were very bad indeed. The business had had a hard experience. When the war began most makers thought it would not last very long and they erected temporary buildings to produce the things that were most needed. These had to be replaced as plans were changed. In the Schoellkopf Works before 1914 they were making some 16 out of the 300 and odd colors in largest use. By January 1, 1916, they were making 40. By 1917 the ordinary needs of industry were beginning to be met with some satisfaction and during that year they produced 46,000,000 lb. of color at a value of \$57,000,000 against \$2,000,000 worth in 1914. Advance would have been impossible without the splendid responses from chemists, engineers and mechanics as well as from foundries and machine shops. Some original research is now under way in the laboratories but the main efforts have been in relation to improvement of quality. This has been so successful that very few colors now fall short of the best German products. Ninety per cent of the complaints today are due to the faulty application of dyes. The dictators of fashion call for shades which involve the use of a mixture of dyes of which some one or two may not be made as yet. Then substitutions of dyes that are not proper for the purpose are made—and trouble follows. Among the needed colors he was glad to say that alizarine and fast cotton vat dyes will soon be forthcoming.

He expressed the belief that unless higher duties are placed upon these materials the industry will be seriously jeopardized after the war. On the other hand, if the industry were to receive the protection of high duties for ten years he believed it could thereafter get along without any protection at all.

PROGRESS IN APPLYING NATURAL DYES

DR. EDWARD S. CHAPIN of Boston spoke on An Important Factor in Natural Dyestuff. His paper was a scholarly presentation of the chemical structure of the tinctorial bodies of natural dyes, reviewing the studies of Professor Perkin and others. He brought out arguments in favor of certain natural dyes and declared that logwood, if properly dyed upon wool is fast against light and that it will not crock. Dyers preferred coal-tar colors, he said, because they are so much easier to apply. Research is under way and the outlook is promising that certain natural dyes may be so treated as to make them as easy to apply as the synthetic colors.

DR. J. MERRITT MATTHEWS spoke On the Application

of Dyestuffs in Cotton Dyeing. The special nature of cotton and its requirements in this respect were pointed out.

MR. ELLWOOD HENDRICK told of the beginning of the coal-tar dye industry in this country at Albany, N. Y., and of his connection with it as chemical director in 1881-4.

MR. CHARLES R. DELANEY of Hanover, Pa., in discussing the Manufacture, Use and Newer Development of Dyewood Extracts, told with almost aggressive modesty how quiet and unassuming the makers of dyewood extracts had been while all the country had been talking about coal-tar dyes. Nevertheless he declared that they were growing fast; he agreed with Dr. Chapin about the supremacy of logwood on wool in reference to its bloom and richness, and claimed that dyewood extracts were the natural and best colors for silk, wool, leather and wall paper. He said that before the war his firm had shipped large quantities of Flavine to Germany and Switzerland for wall paper. They had sold hardly any in America because they had preferred to save their self-respect rather than compete in the market with German manufacturers. There is, he said, roughly speaking, \$50,000,000 invested in the dyewood industry in this country today.

COLOR LABORATORY OF THE BUREAU OF CHEMISTRY

DR. H. D. GIBBS of the Bureau of Chemistry, Washington, described The Color Laboratory of the Bureau of Chemistry. It is not yet finished and part of what is already constructed has been turned over for war work. But when completed it will be a building 150 x 70 containing 9 laboratories, power and refrigeration plants, nitrators, sulphonators, etc. in short a complete small factory. The plans are very ambitious, being no less than the studies of processes and their details for making dyes for the benefit of the general welfare. Although 80 per cent of the staff and of the work is now on war problems, the following is the plan, and, so far as they have gone, the method:

It is aimed to study dye intermediates, dyes, dye methods and medicines. Work has already been done in chlorination, sulphonation and oxidation. Chlorination is effected by means of light catalysts and the studies of sulphonation and oxidation are also made in the vapor phase. As soon as the work in hand is sufficiently advanced separate pamphlets will be published. Such a pamphlet will shortly appear on H-acid. Another study is on the production of phthalic anhydride by oxidation of naphthalene in the vapor phase. A very interesting work is on cymene, recovered as waste from the sulphite pulp industry. The successful nitration of cymene has already been accomplished and the record published in the *Journal of Industrial and Engineering Chemistry*. From this the development of a large series of derivatives is opened up and as many are indicated as there are of aniline. It is especially promising in the field of dyes of which some have been produced already. What part these new dyes will play in industry is an open question but the outlook is promising. Some 2,000,000 gallons of cymene are available annually from the production of spruce pulp. Further studies have been made on the purification of anthracene pressed cake.

The influence of a government laboratory working

over the problems and publishing its findings is likely to be of marked effect. It emphasizes the fact that development along this line is of general public interest rather than an industrial speculation. And although the speaker did not dwell upon the subject, it appears to us as though it would discourage secrecy in industry, and it is usually a good thing to discourage secrecy. In our opinion it is a sign of bad conditions for industry to manufacture in secret and to sell with a brass band. This puts the emphasis upon selling and discourages attention to the art of producing.

PROBLEMS IN TESTING DYES AND INTERMEDIATES

DR. E. W. PIERCE of New York spoke on Problems in Testing Dyes and Intermediates. He said the human eye cannot detect a difference of less than 5 per cent in shades although by colorimetric methods this may be brought down to 2 per cent. He laid stress on differences produced by differences in water and said that adulterants such as dextrine often act as protective colloids and slow down the process. He held that we must regard the process of dyeing as one of adsorption and we should bear in mind that we are at all times dealing with problems of colloid chemistry in the dye bath. Referring again to the effect of impurities he recalled the use of synthetic indigotine when it was introduced. The natural product worked well in a large dyehouse under his observation, but the synthetic product, which was pure, gave all sorts of trouble. The goods were uneven and streaky. The fact was it dyed too rapidly, lacking the usual organic impurities which served as protective colloids and thus slowed down the process. The addition of certain organic matter to the bath overcame the difficulty and enabled the dyers to use the synthetic as well as the natural product.

He called attention to the fact that wool differs at the roots from the tops, and that two lots of wool that look very much alike may dye if treated separately, nearly alike but that if dyed together, one lot may rob the other of its color so that part will come out dark and part very light. These differences, he suggested, may be due to the presence of bleached shoddy.

QUANTITATIVE VS. ANALYSIS OF DYESTUFFS

MR. ALFRED H. HOLLAND of the Buffalo Works of the National Aniline & Chemical Co. presented a paper on Quantitative Analysis of Dyestuffs which he had worked out in connection with Mr. Willard Watkins in their laboratory. He said there was very little literature on the subject, but that they had found the work of great value in the work in that it enabled them to determine yields. He gave a number of methods. He took issue with Dr. Pierce as to the colloidal nature of dyestuffs; said that the processes seemed usually to proceed as Dr. Pierce described but he knew for a fact that naphthol yellow, for instance, contained crystal water and that indigo, on standing in solution, shifts from a colloid to a crystalline state. No dispute followed, for Dr. Pierce admitted everything and held to his point.

DIVISION OF INDUSTRIAL CHEMISTS AND CHEMICAL ENGINEERS

The dyestuff symposium which was attended by upward of 250 persons was continued in the main ball room of the hotel on Wednesday morning, and on the

conclusion of Mr. Holland's paper and discussion the above division convened with Mr. H. S. MINER presiding.

SUGAR AND CITRIC ACID

The first paper was by Dr. W. D. HORNE of Yonkers, N. Y., on Valuation of Raw Sugars. He proposed an amplification of the polarization methods in vogue. Raw sugars often contain impurities that remain in the sugars after filtration and thus augment the cost of refining in remarkable measure. They have an important bearing on the value to the refiner of raw sugars. He gave his methods in detail. It was an excellent paper.

Dr. GRINNELL JONES of the Tariff Commission described The Citric Acid Industry. He recited the crude methods in vogue in Sicily and the mechanical devices and stratagems that are current in California. He also gave some of the perplexing problems that are likely to come before Congress in the decision of tariff duties on citric acid. In the meantime, of the two products that are sold in competition, tartaric acid will be produced in decreasing quantities if we have nation-wide prohibition, while the makers of edible lactic acid declare themselves to be marching into the market with their wares at a lively pace. Citric acid is made from cull lemons and the greater the demand for it, the more severe is the grading of the fruit and consequently the better is the quality of the fruit marketed. In Sicily the culls often are as much as 40 or 50 per cent of the crop whereas in California, with greater attention to the trees, the culls are seldom above 10 per cent of the crop.

Professor ALEXANDER SILVERMAN of the University of Pennsylvania described his invention of A New Illuminator for Microscopes, using lantern slides. This was his second paper on the subject showing a number of improvements. We have already described the illuminator in a previous issue¹.

DEOXIDIZING STEEL WITH FERROMANGANESE

Mr. ALEXANDER L. FIELD, at the continued session of the Division on Thursday morning read a paper on The Deoxidation of Steel by Ferromanganese. The speaker discussed the function of manganese in steel and admitted that it is not known. He was convinced that the theoretical reaction of $\text{FeO} + \text{Mn} = \text{MnO} + \text{Fe}$ does not take place. On the other hand manganese combines with sulphur to form manganese sulphide which is less harmful than the iron sulphide. When steel solidifies it gives off 24 times its volume of gas, and analysis of that from steel which has been treated with the usual amount of ferromanganese and ferrosilicon shows 3.6 per cent Cl, 0.9 per cent O, 30.5 per cent CO, 52.1 per cent H, 0.2 per cent CH, and 12.7 per cent N. He considered the manganese reaction to be more probably $\text{FeO} + \text{Mn}_2\text{C} = \text{Fe} + 3\text{Mn} + \text{CO}$. The paper was one of considerable extent and its content is but partially indicated in the foregoing.

WAR'S EFFECT ON COTTONSEED OIL

Dr. DAVID WESSON of the Southern Cotton Oil Co. discussed The Cotton Oil Industry in the War, illustrated with lantern slides. Before the war mills had trouble in getting seed because mill owners could not compare the prices they paid for it or even talk about

them with a view to agreement without the danger of being sent to prison. Now Uncle Sam fixes the prices and if a mill owner does not live up to them he loses his license. Dr. Wesson did not complain; he merely observed that things were different from the way they used to be. The amount of oil per ton used to vary according to the quality of seed. Now 135 lb. per ton must be squeezed out anyway. And owing to the need of linters for nitrocellulose, every ton must furnish 145 lb. of lint which makes it necessary to keep the saws in perfect order. Owing to the demand for fats some 1,700,000 bbl. of other oil has come upon the market. In districts where the boll weevil ravages the cotton fields the farmers have taken to growing peanuts for their oil.

A paper by Mr. J. F. G. HICKS on Yttrium Mixed Metal was read in his absence. He described the metal as burning in the air in a manner similar to magnesium and said that it decomposes water with considerable energy. It is very difficult to prepare and it gives off an odor of something like calcium carbide. He believes it to have value in alloys with other metals and is engaged in more extended experiments which he will report later.

GILSONITE SHALES AND GASOLINE

Mr. GUSTAV EGLOFF described the conclusions reached by Mr. Robert Moore and himself on gilsonite. They have been working on shales to determine the amount of bituminous material to be recovered from them. Gilsonite is a pure bitumen found in Utah in large quantities and is used in rubber, lacquers, pipe-coating, etc. It melts at about 300 deg. They distilled it at atmospheric pressure to find the yields of motor spirits or fuel oil and ammonium sulphate available. By destructive distillation they obtained at the rate of 160 gallons of fuel oil of sp.gr. 8.8, or 29.4 deg. Bé. per ton. The ammonia yields were too erratic to report. From the recovered oil they got a gasoline fraction of 20 per cent. But while it has the volatility of cracked gasoline it would not serve on the market in its place. It has a light lemon-yellow color when first distilled which turns to a deep red on standing. This they were unable to remove. It also contains nitrogen, sulphur and oxygen compounds. Their results have but negative value at present because gilsonite now sells at from \$60 to \$70 a ton and it would be ridiculous to think of making fuel oil from it at such a cost. But the shales are on hand and there are reasons for addressing ourselves to the subject of their use with intelligence.

The petroleum supply is growing short. The Geological Survey estimates that the total available oil in the United States was originally 7,000,000,000 barrels. Since 1859 we have taken out 4,000,000,000 bbl. leaving 3,000,000,000 bbl. still to be produced. At present rates our petroleum deposits are likely to be exhausted in 15 or 20 years; therefore we must look around for other sources of supply.

Shale contains many times this quantity. It is held that over 20,000,000 bbl. of oil may be extracted from the Colorado shales alone which contain from 2 to over 90 gal. per ton and may average around 20 gal. and 15 lb. ammonium sulphate. And yet despite the lurid articles in the daily press telling how to get rich quick on shales, and the offers of stock to investors with

¹Published in this journal, March 15, 1918 and Sept. 28, 1918.

the assurance that they are coming in on the ground floor and that all they have to do is to put up their money to become millionaires, the investment outlook is far from promising. No technical work has been done so far, and the cost figures that the speaker had seen had been based entirely on laboratory experiments. Again oil that is drawn from the earth is still cheaper. We have the 3 billion barrels left to compete and 300,000,000 barrels available in Mexico. The entire problem needs working out. Mr. Egloff doubted if an investment of less than \$100,000,000 would see the industry organized, established and equipped to market its production. He expressed serious doubts as to the wisdom of investing in the shale-oil industry at present except for a long wait.

A second address by the same author was on The Steam Distillation of Gasoline. In this Mr. Egloff argued in favor of straight firing in preference to using steam and claimed a large economy in favor of it.

An abstract was read of a paper by Mr. HARRY F. LEWIS on The Quantitative Estimation of the Important Constituents of Crude Anthracene.

GROWING SUGAR CANE UNDER PAPER

Mr. H. E. HOWE of Arthur D. Little, Inc. gave the substance of a paper of Dr. Arthur D. Little on The Eckhart Method of Sugar Production. This consists in what is called "row mulching" under Eckhart patents whereby the rows of young cane are covered with a specially prepared paper which the sharp rigid young sprouts penetrate in growing while the weeds curl up under it and die. In the Hawaiian climate with its high temperature and heavy rainfall the growth of weeds is exceedingly prolific so that the cost of labor in weeding becomes a leading item of expense. By this means 70 per cent of the labor cost is eliminated and an increase of 25 per cent in the yield of cane is obtained. A method to make the special paper from excess bagasse was developed in the Little laboratory and a paper mill for the purpose is in progress of erection in Hawaii.

STANDARDIZING ODORS AND STENCHES

Mr. V. C. ALLISON presented a paper for himself and Mr. S. H. KATZ on An Investigation of Stenches and Odors for Industrial Purposes. The use of various substances having high olfactory properties has long been availed of for warnings in mines, to determine the tightness of joints in plumbing, to observe the circulation of ventilation and for other purposes. To aid in determining the best materials for this purpose the authors have constructed what they call an odormeter whereby the degree of concentration may be approximately determined. A sensitive nose on the part of the operator is required. Five empirical degrees of increasing intensity were fixed upon and by this means they were able to divide the materials to be tested into three general groups. Those of the first group become evident to the olfactory sense in dilution of 5 parts per million of air. The second group require 100 parts per million and the third, 1000 parts per million.

So far as we are aware this is the first instrument designed to establish olfactory standards and we sincerely hope that studies on the subject may be continued.

Mr. H. E. HOWE concluded the session by an illus-

trated description of the industrial research and testing laboratory of Arthur D. Little Inc. at Cambridge, Mass., which we have already described in a previous number of this Journal.

POTASH SYMPOSIUM

This was held under the auspices of the Division of Industrial Chemists and Chemical Engineers and it was made a part of the general session.

Mr. J. W. TURRENTINE of the U. S. Department of Agriculture spoke on the Experimental Kelp Potash Plant of the U. S. Dept. of Agriculture. Research began in 1910, being instigated by the Bureau of Soils in the belief that other things besides potash were available from it. A Congressional appropriation was finally made and a plant costing about \$100,000 has been in operation since the end of August, 1917. It has a theoretical capacity of 150 to 200 tons daily but treats about 80 tons, owing to difficulties of harvesting. The kelp is stored and dried by direct heat in rotary kilns, the current of heat opposing the run of kelp. In the government plant the kelp is substituted to destructive distillation in vertical retorts, the charred residue containing KCl, iodine and NaCl. This is dissolved and evaporated, the sodium and potassium salts being separated by fractional crystallization. The work on distillation products, which stand between those of wood and coal, is not complete. The results so far are interesting and encouraging but not yet ready for reporting. Under present conditions the plant meets operating expenses.

In regard to the subject of potash in general Mr. Turrentine considered the prospects of the several supplies respectively from Nebraska lakes^a, Searles lake^b, kelp^c and cement dust^d. The raw material of the Nebraska lakes contains the highest percentage of potassium and this was the source of the greatest supply last year. Although commercially successful at present they are threatened with early exhaustion. On the other hand there appears to be subterranean deposits of brine which are in part drawn upon now. No prospect of great deposits similar to those found in Germany or in Alsace was mentioned in this connection.

Dr. F. W. ZERBAN spoke of A Useful By-product Obtainable in Potash Manufacture. He referred to a decolorizing carbon of very high potentiality obtained from the kelp char. The best results are obtained by carbonizing the unleached char quickly under conditions in which the gases may easily escape.

Dr. W. H. ROSS was absent on military duty and an abstract was read of his paper on The Extraction of Potash from Cement Mill and Blast Furnace Dust. The potash content of cement dust varies from 2 to 20 per cent K₂O. The main difficulties are involved in the cost of transportation of the dust and in the fact that the potash recombines to form insoluble silicates. This can be made soluble again by digestion under pressure in the presence of lime. Generally speaking 75 per cent of the potash in cement dust is in soluble form.

Mr. H. W. STOCKETS gave a talk on The Potash Situation. He emphasized the fact that of two factors necessary to food production we had been in the habit of

^aThis Journal, July 15, 1918.

^bThis Journal, Dec. 15, 1917 and Sept. 25, 1918.

^cThis Journal, Sept. 25, 1918.

^dThis Journal, June 1 and Sept. 25, 1918.

^eThis Journal, Sept. 25, 1918.

drawing upon foreign countries. The labor we got from anywhere except the Orient. In regard to the other factor, fertilizer, we drew our potash from Germany, the pyrites for sulphuric acid to make acid phosphate we drew from Spain and the fixed nitrogen we imported from Chile.

The development of the greensand deposits of New Jersey has been progressing on a limited scale. The cost is less than \$1 per unit of K_2O , obtained by digestion under pressure with lime. There are also in Colorado some ten million tons of tailings from gold mills that contain about 10 per cent of potash concerning which the prospects are favorable. Mr. Stocketts believed that some sort of a subsidy from the Government to prosecute research in this respect is under consideration.

Mr. GRIMWOOD, formerly of the Trona Corporation, was invited to speak. A new company called the Borosolvay Co. has entered the field organized by the Pacific Coast Borax Co., and the Semet Solvay Co. of Syracuse, N. Y., and is now operating. The speaker is engaged in the construction of a plant for a third company which looks forward to the production of 250 tons daily.

SOCIAL FEATURES OF THE MEETING

On Tuesday evening an informal dinner took place at the Hotel Statler at which no speeches were made; but during the meal a most obstreperous Jazz band provided the now popular tumult, thumping and dissonances. After dinner a smoker was held in the same room. The band remained and besides this there were speeches and songs. On Wednesday evening a reception was held at which Dr. CHARLES H. HERTY read Dr. Nichols' presidential address. It was entitled "A Retrospect and an Application" and gave from the writer's personal experiences, an interesting history of the beginning of the American Chemical Society in 1876, and it told of the doubts entertained that a society could be organized upon such a subject as chemistry. Its present membership of over 12,000 was due to friendly coöperation and Dr. Nichols made an earnest and eloquent plea for that kind of working together that looks to the general welfare, declaring that success in its true sense consists far more in making the most of ourselves than it does in the acquisition of property.

On Thursday evening the Society was entertained at the Country Club at a delightful dinner by the Grasselli Chemical Co., and on Friday most of the members who remained made a trip either to Akron or to Wadsworth, Ohio, to visit the industrial establishments at those places. Other excursions to visit the Cleveland sewage plant, the steel industries of the city, and to Oberlin to look over the college and its chemical laboratory, Wednesday afternoon.

In the foregoing we have reported only the general meeting and those held under the auspices of the Division of Industrial Chemists and Chemical Engineers. We have had no opportunity to confer with the authors of the various papers and stand open to corrections for errors and omissions.

A feature of special interest at these meetings is the frequent opportunity for informal discussion which occurs. This has to do not only with current research but one is frequently reminded of research which has

been recorded and forgotten. As an example of this our attention was called incidentally to a paper by Jovitsch, a Russian chemist, recorded some ten years ago either in the *Journal* of the Russian Society of Physical Chemistry or the German *Berichte*; the relator could not remember at the time. Jovitsch passed ethylene and acetylene, in separate experiments, through a heated tube in the presence of a silent discharge. From ethylene he obtained a solid condensation product, $C_{10}H_{12}$, which had strong radio-active properties. From acetylene he obtained a condensation product $C_{10}H_{14}$ with still stronger radio-active properties. He was unable to account for all the carbon originally present and he argued from this that along with his condensation products he had obtained a highly radio-active new element. In view of the great need of radio-actives, the experiment would seem worth looking up and confirming.

Other sections in which papers were read were: Agricultural and Food Chemistry, Pharmaceutical Chemistry, Biological Chemistry, Fertilizer Chemistry and Organic Chemistry.

World's Leading Filters on Exhibition

THE National Chemical Expositions have always been an opportunity for machinery manufacturers and especially for the filter companies to render definite service to the chemical and allied industrial concerns by exhibiting their latest improvements so that the prospective purchaser can conveniently decide which machine is the best for his requirements. Certainly never has the chemical manufacturer had a better opportunity of making the right selection than at this Fourth Chemical Exposition in which the excellence of the filter exhibits surpasses all previous shows. In no place on the globe is it possible to view such an array of filtration machinery. The world's best at its best is here displayed so that the superintendent or the manager in an hour or so gets the several points of advantage in the different competing machines that he could not possibly get in days by interviews with representatives or by poring through the literature of the several companies.

It is becoming more and more acknowledged that of the different types of filters some are better adapted to handle certain materials and others other liquors, such that the manufacturers are recommending different machines for varying kinds of work and the several companies are to a certain extent specializing in specific fields.

With materials requiring a simple dewatering, i.e., the separation of the liquid from the solid with the solid discharged as a transportably dry material it is but necessary to determine if they can be effectively handled in the continuous type of filter which have so advanced in their operating efficiency that they are admitted to be the leading type of machines for this class of work. The Oliver Continuous Filter Company in their Oliver filter, the Industrial Filtration Company in their zenith rotary filter and the United Filters Corporation in their American continuous suction filter are the leading manufacturers of this type machine and each has a comprehensive exhibit making it a simple matter for the buyer to make his decision. If the material cannot be handled in a continuous vacuum machine but a self dis-

charging pressure can be adapted, as is often the case when high temperatures are required, the Sweetland and Kelly filters as put out by the United Filters Corporation or through E. E. Lungwitz, who handles Kelly filters, will be found to be efficient and economical machines. The Atkins Shriver automatic discharging plate and frame filter press is a new type recently developed for which much confidence is felt of its proving in practice to be another type applicable for this duty. This machine will also augment the work of the familiar plate and frame filter presses as shown by the Shriver Company and the Provost Engineering Co. which are still the leading machines for delivering dry cakes which have to be kiln dried or which have to be shipped as discharged from the filter.

In those plants where the material handled requires the solid to be washed free of soluble prior to discharge a modern filter is the rational choice provided the deposited solids are capable of discharge from the filter medium. If a sufficient wash is obtained on passing the cake through an atomized spray wash water without submergence the continuous filters pointed out above offer the best selection. Superintendents will find that the old objection of the spray permeating the entire filter room is now obviated by housing the sprays and much more adequate wash is being obtained by better control of the vacuum during the different operations as well as by using weak liquor washes. For those liquors requiring pressure type filters or those needing prolonged washing periods with the cake completely submerged the Kelly and Sweetland filters are first choice and especially the latter where the cakes can be uniformly built and the excess unfiltered liquor minimized so that the wash water may be turned on directly without draining the excess unfiltered liquor. Materials handled by plate and frame presses are more thoroughly washed when a refiltration of the cake puddled with wash water is practiced although washing type filter presses may be used to effect a superficial wash.

For liquors containing small amounts of a difficultly filtered solid which is a waste product and to which Filter-Cel may be added as a filter aid the Sweetland sluicing type filter has well earned the premier position. In such clarifying problems thin cakes only can be formed and the immense filter area obtained by putting the filter leaves of this machine on close centers as well as the ability to clean the cloths conveniently and without opening the filter account for the popularity of this type of machine.

In handling acid liquors each of the manufacturers are recommending special equipment. The Shriver and Provost Engineering Companies offer their wooden plate and frame filter presses, the Industrial Filtration Company their acid proof rotary filter and their open tank vacuum leaf filters of wood or lead lined construction, the Oliver Continuous Filter Company their acid proof Oliver filter and the United Filters Corporation their lead lined Sweetland filter and acid proof American filter. Cotton and woolen fabrics are the filter media used and if the precaution is taken of keeping the medium wet when the machine is idle so that the acid does not concentrate with the drying of the cloth a good length of life can be obtained.

Alkali liquors were once thought impossible of handling in modern filters but Sweetland's patent metal-

lic filter cloth put out by the United Filters Corporation and the metallic filter cloth, patent on which is soon to be issued, of the Newark Wire Cloth Company have changed this so that it is now practical to handle even the heaviest of caustic liquors with marked efficiency. In some cases a scale formation must be removed by periodic acid washes but the cloth otherwise stands up practically indefinitely.

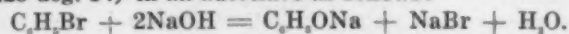
The art of filtration abounds in "tricks of the trade" so that different methods of operation of a single machine will often vary the efficiency obtained through wide limits. Yet some materials offer such obstinate difficulties that special machines can more effectively handle them, hence the zenith continuous rotary hopper of the Industrial Filtration Company and the continuous sand filter of the Oliver Continuous Filter Company. Each of these machines is primarily designed to handle those liquors the solid content of which is free filtering and of a tendency to rapidly settle. The application of these machines is also proving more and more advantageous as a substitute for centrifugals in drying crystals from the mother liquor.

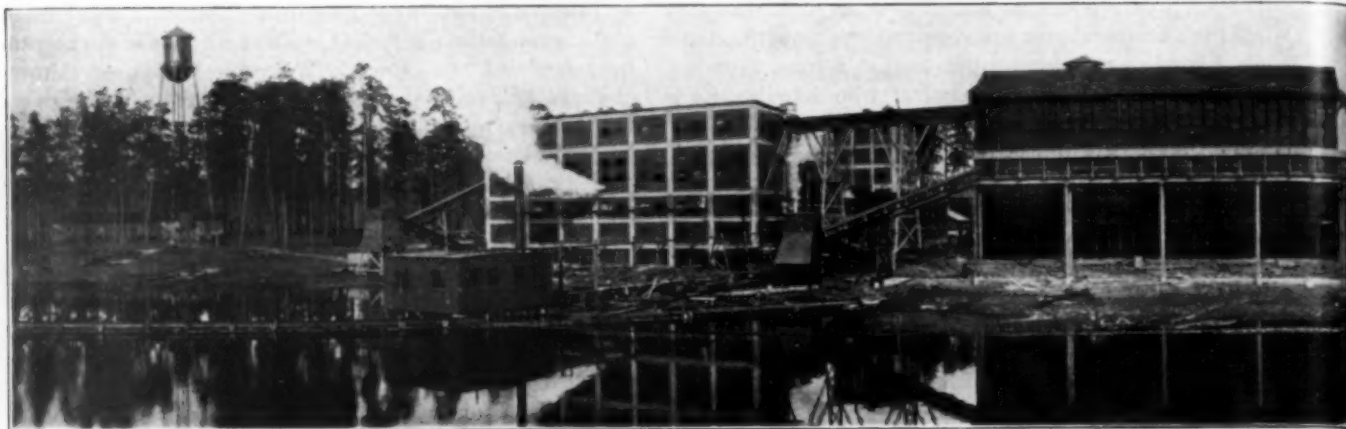
Some radical improvements feature some of the exhibits and are worthy of note. The United Filters Corporation are showing a new design of hinge on their Sweetland filter which not only is simpler than their previous eccentric hinge but is also capable of more positive and convenient adjustments. Lugs are cast on the rear of the upper half and drilled to accommodate swing bolts which are adjustable at the top. The lower end of the swing bolts terminates in a forked hinge bearing on which the lower half is suspended. Adjustment is made by moving the nuts on the top of the bolts and obviates such accurate machining as was required with the older type hinge. The American continuous suction filter is now being supplied with a receiving pan continuous in the rear of the machine instead of individual pans as formerly built which allows of greater accessibility and better control of the overflow.

The Atkins Shriver automatic discharge filter press has been redesigned so that by use of a friction clutch no excessive load can be put on the driving mechanism and the paddles are being made of cast iron shaped so as to allow the dislodged solid to more easily escape to the central discharge outlet. The paddle shafting has been strengthened so that the paddles travel in a fixed position, thus insuring freedom from the plows digging into the cloth. This machine abounds in unique mechanics and is held to be practically fool proof now.

The acid proof Oliver filter of the Oliver Continuous Filter Company is now equipped with lead plates covering the sides of the machines and as the axis of the filter is located above the maximum level of the liquor in the lead lined pan rigid iron construction is provided without the metal coming in contact with the liquor.

Phenol from Mono-brom-benzol.—It has been generally accepted heretofore that the halogen compounds of benzene were not suited for the manufacture of pure phenol. Mr. HERBERT H. DOW of Midland, Michigan, patents a method of causticizing C_6H_5Br with dilute aqueous solution of NaOH at 300 lb. per sq.in. pressure (425 deg. F.) in an autoclave as follows:





Wood-Waste as a Source of Ethyl Alcohol*

The Economic Causes for Past Failure in This Industry—Co-operation of Lumber Industry Essential to Success—Technical Problems Solved—Costs at Fullerton, La.

By GEORGE H. TOMLINSON

FOR some years we have been hearing more and more regarding waste wood as a source of ethyl alcohol. The amount which is thus being made, however, is still but a fraction of the nation's supply and within the past few years has not been extended irrespective of the great and increasing demand which the war has developed.

It may be advanced that sufficient capital is available and competent technical skill can be secured; but if the proposition is, therefore, all that has been claimed, the question naturally occurs, Why has more rapid progress not been made? Is the proposition fundamentally unsound, or does it still offer the very considerable possibilities which have been predicted?

We all realize the distance to be traveled between the discovery of a chemical reaction and its successful commercial development and application. In this case, as a matter of fact, one hundred years have already elapsed. The pitfalls to be crossed, both technical and commercial, are legion, and the more unusual, attractive or revolutionary the proposition may be, the more difficult may its pathway become. Premature development and extravagant or unsound exploitation can prostitute an undertaking, no matter how promising it may be, and when this occurs in connection with a process which has not been already established, disaster is invited.

INDUSTRY DAMAGED BY PREMATURE AND UNSOUND PROMOTION

I think I may safely say that such a condition of prostitution represents the present status of this particular industry and explains to a large extent its present position of apparent stagnation, even at this time when its further development should offer such unusual opportunities.

In this connection the several company flotations which have occurred have been initiated by promoters having no particular interest in the business itself. This has resulted in only a small portion of the rela-

tively large amount of capital which has been raised in connection with the undertaking filtering through for its actual development. Adequate research has not been undertaken, the plants which already have been constructed have been started prematurely in locations having little regard to the commercial conditions involved, all in order that a rapid showing might be realized and a quick turn made by the promoters. Any complete consideration of this aspect of the proposition can only lead to the conclusion that the miracle is that anything has survived. The fact, however, that several million gallons of alcohol have actually been produced from this source, and that at least two plants have been operating more or less continuously over a period of years, irrespective of the technical and commercial handicaps from which they still suffer, justifies the belief that ultimate success is established, and that the undertaking offers much promise for the future.

It was originally assumed that almost every sawmill represented a possible location for the establishment of such a plant. Since there were almost innumerable sawmills at which the disposition of wood-waste was a problem, even constituting in most an element of expense, it was also assumed that this material could be purchased at a purely nominal figure. It therefore seemed logical that favorable contracts for wood-waste could be made, and, having sufficient capital, the company controlling the process could establish an endless chain of plants producing ethyl alcohol, and thus soon secure entire control of the alcohol market.

On this basis and plan the business was projected. It was soon found however, that while there was no question regarding the number of sawmills or the extent of the waste wood which is produced, nevertheless there are very few at which conditions are entirely favorable for the establishment of the extensive plant which the manufacture of ethyl alcohol requires. The life of the lumbering operations may be uncertain, the water supply deficient, labor or transportation operations unfavorable, or any one of a number of such factors may be found which jeopardize success.

*A paper read at the Fourth National Exposition of Chemical Industries, Sept. 28, 1918.



The fact that sawdust and all the other forms of waste wood are so bulky and difficult to handle precludes transportation, and therefore confines its processing to the point at which its production occurs. When approached, the lumberman who has a suitable location soon recognizes the advantage which he enjoys, and any outside company wishing to do business must pay his price, and if once established has no other source of supply. It can at once be seen that any large or general development along these lines was impractical and bound to fail.

A NEW START MUST BE MADE ALONG DIFFERENT LINES

In the manufacture of our lumber we know that many millions of tons of waste wood are annually produced, and the potential asset which this waste represents is being recognized. If any considerable part of this, however, can be converted into alcohol, there is probably no more important industrial use which it can be made to serve. That this can be done in a limited way has now been completely proved, but in order to greatly extend its application, the development, it would seem, must follow different commercial lines from those along which the start was made.

The process which has been developed naturally divides itself into two very distinct and separate steps. We first convert a certain portion of the wood, amounting to a maximum of about 28 per cent, into soluble carbohydrates which are then separated in the form of a clear solution which normally contains from 10 to 12 per cent. As a second step we have the fermentation and distillation of this product for the production of ethyl alcohol. It is not essential that both of these operations be conducted at one point, since the sugar solution can be evaporated, and then becomes quite the equivalent of cane molasses, which at present constitutes the principal source of our alcohol supply. Molasses, as we know, is transported to, and assembled at, the most favorable locations for alcohol production, there to be manufactured on the largest scale. Applying this same principle we immediately find that the scope of the wood process is greatly extended. Not only can wood-waste be utilized at those comparatively few locations at which suitable conditions for the manufacture and distribution of alcohol are found, but almost every sawmill with an assured capacity for a reasonable period can be considered as a possibility. At the most desirable locations, complete installations for manufacturing alcohol can, of course, be made; at the others molasses plants

can be installed and their product transported to existing distilleries or to new ones at which the product of several such units can be assembled and used.

The investment required for such a molasses plant is small compared with that which the complete distillery involves, and the importance of this can at once be seen in extending the scope of the undertaking. Furthermore, smaller units can be operated economically, less skilled labor is required, and it does not come under the exacting regulations and control of the Internal Revenue Department as is the case if alcohol is produced. Furthermore, if the molasses product is sold to those already engaged in the distilling business, many market and other trade difficulties are removed which only those having experience in the alcohol business fully appreciate and which the smaller producer might be unable to overcome.

LUMBERMEN MUST COÖPERATE AND TAKE ACTIVE INTEREST

In order that such a plan may be carried out, however, it would seem that proper headway cannot be made unless the lumbermen themselves assume the initiative, or at least give it their most sympathetic coöperation and support.

In order to operate to the greatest economy, such a plant should preferably constitute a part of the lumber operation itself, being operated under the same management and on the same premises, thus avoiding all unnecessary handling and storing as well as duplication of equipment or staff. In addition to this, the lumberman, controlling as he does the raw material, can alone determine and regulate its most economical disposition and use, and unless he is financially interested in the subsidiary company its supply of raw material can never be fully assured.

The lumbermen, however, are naturally cautious about engaging in enterprises apart from their regular trade. In the past, numerous byproduct ventures which have been taken up in connection with the lumber industry have failed and very few have succeeded. That this has been due either to their being entirely impractical or as a result of incompetent technical advice is probably true, but nevertheless these failures have seriously retarded others from embarking in the like.

In this case, however, the uncertain and costly experimental expense has already been borne by those that have been blazing the trail, and the success of the enterprise from its technical aspects at least is demonstrated.

It now remains for some one to make a fresh start and thus step in and take advantage of the mistakes of the past. If this is done along sound business lines by one of our progressive lumber concerns, complete commercial success appears inevitable. Should it be found that progress along these lines is blocked as a result of patents, those controlling such patents would be well advised to accept an equitable royalty in order that a proper start should be made. Once this step is taken, others will follow and real headway then be made.

PRODUCTION OF MOLASSES SHOULD APPEAL TO LUMBERMAN

From the lumberman's point of view, the production of molasses should offer a very strong appeal. While there are at least several profitable uses to which his waste can be applied aside from its use as fuel, the others, as far as I know, demand sorting or selection. In the case of producing molasses or alcohol, any part or all of his waste can be used even including that which constitutes his fuel supply, since the residue left after extracting the sugars, representing 70 per cent of the original amount, is not depreciated in fuel value. In other words, that portion which is actual waste and is being destroyed can be combined with the amount being burned for fuel, and 70 per cent of this total will still be available for power development. In considering and comparing the values extracted, it is therefore necessary to consider also the much larger tonnage which this process utilizes. The cost of production compared with the cost of cane molasses, however, is the vital element upon which this development must ultimately depend.

In June, 1913, the costs given below were obtained in the alcohol plant then operated by the Standard Alcohol Co. at Fullerton, La. The actual cost of this plant at that time amounted to \$456,920.56. Of this sum, about \$200,000 represented the expenditure for the plant and equipment involved in the conversion of the wood into sugar and the separation of this in the form of a solution. The balance was required to provide the necessary plant and facilities for fermenting and distilling the latter and converting it into alcohol.

COST OF PROCESSING AT FULLERTON, LA.

Operations were conducted for 22 days at three-quarter capacity. During this time 6125 tons of green waste wood containing 48 per cent moisture was processed, giving a yield of 1,688,600 gallons of sugar solution averaging in strength 10.3 per cent.

The cost of processing this, exclusive of the cost of the wood, but including all other material, labor, power, factory expense and overhead, together with proper allowances for depreciation, amounted to a total of \$5,371.56, or 31.8 cents per hundred gallons of the strength stated. To convert this into molasses, the cost of the equipment for this purpose would have to be added to the cost of the plant and the cost of its operation to that of the product. However, since the residue from the process supplies the necessary fuel, this concentration can be effected at very little cost.

Assuming a concentration of 8 to 1, the resulting 124 gallons of molasses which one hundred gallons of the dilute solution will yield may be figured at 2.5 cents per gallon or, say, 3 cents including the evaporation. This

is of course a lower figure than that at which cane molasses has been sold in recent years and very much lower than any price which may be expected to prevail in the future. What this price may be is problematical, but 12 cents is probably none too high.

When we compare the fermentable contents of the product of this run with that of cane molasses, the showing is not so favorable. During the month the average production of spirit amounted to only 4.87 proof gallons per 100 gallons of dilute solution. Using this same percentage, a gallon of wood molasses would yield only 0.39 gallons of proof spirit, whereas cane molasses yields practically gallon per gallon. This gives a cost of 7.7 cents for wood molasses to yield the spirit given by a gallon of cane molasses. While even on this basis it appears that a profit is fully assured, the result which this comparison gives is far from representing the best which can be obtained since the quality of this product was poor.

From the figures given it can be calculated that only about 8.5 per cent of the dry wood was converted into sugars which were fermented, although approximately 24 per cent of the wood was extracted in the solution obtained. It has been repeatedly demonstrated, however, on both large and small scale experimental operations that 26 to 28 per cent of the wood can be converted into water-soluble carbohydrates as a result of simple acid hydrolysis, and that under the best conditions over 80 per cent of this is obtainable in the form of fermentable sugar. In place of realizing this result, not over 50 per cent of the water-soluble carbohydrates obtained has actually been fermentable in the product of the plant which I have mentioned, and the average has been less.

PATENT CONFLICT HAS RETARDED PROGRESS

It remains to translate such experimental results, depending as they do upon the conduct and control of the chemical reactions involved, into commercial practice. To do this requires little change in the mechanical methods of handling which were used at Fullerton and largely developed by myself. The mechanical efficiency of these is indicated by the very low per-gallon cost which I have given and which there is no reason to believe should be increased in effecting the much more complete hydrolysis which it is easily possible to obtain. That this has not already been done, I attribute principally to patent conflicts which have directed this development along unnatural lines in the effort to avoid infringement and permit exploitation. In undertaking any new installations, however, if full advantage is taken of existing knowledge and the experiences of the past, the production of a wood molasses equal to cane molasses in fermentable value is assured, and at a cost per gallon which certainly should not exceed that of the low-grade Fullerton product which we have considered.

The lumberman already can see a limit to his timber supply and is rapidly being forced, for this reason, to recognize the necessity of conserving all that is left. Nevertheless, he is still burning 50 per cent of his logs either under his boilers or in his refuse destroyer. Every ton of this waste can be made to yield over 30 gallons of molasses without disturbing in any way existing methods of operation, unless it be that of the

expensive destroyer which every large sawmill still maintains. Allowing but three cents per gallon profit on the molasses which can thus be made, this would be equivalent to an additional profit of almost \$2 on a thousand feet of lumber, an amount probably quite equal to the average profit realized on the lumber itself. In this, it would appear that we may have an almost unlimited source of molasses within our reach, which the distiller can readily convert into the highest grade of ethyl alcohol without any, or little modification in the equipment which he already has at hand.

OPPORTUNITY FOR READJUSTMENT OF DISTILLING BUSINESS

With drastic prohibition as a probability of the future, as well as the necessity of conserving everything which can be used either directly or indirectly for food, this should offer a means by which the distilling business can readjust itself to meet these conditions, and at the same time provide alcohol in such quantities and on such a basis that its much wider industrial application becomes a possibility, with all the consequent commercial advantages to which this would lead.

With proper coöperation to this end between the lumber and distilling interests, it should be possible to rapidly realize this condition to their mutual advantage, and at the same time release for other use the immense quantities of food products now used for alcohol production.

When the facts which I have attempted so inadequately to present are more fully recognized, and the proposition is taken in hand by those having a vital interest in its development and success, it may be expected to become a business of the greatest magnitude and importance, and wood-waste should become the principal source of ethyl alcohol.

Niagara Falls, Canada.

Separation of Aromatic from Paraffine Hydrocarbons.—The addition of some suitable semi-miscible liquids to the mixed hydrocarbons obtained in the distillation of petroleum, to separate the aromatic toluol, bonzol, etc., by selective solution has been one of the important problems of the munition chemist, as no satisfactory direct distillation separation is satisfactory, the vapor pressures of the members of these series not having a sufficiently wide margin for making good fractionations. Liquid sulphur dioxide has been experimented with considerably in laboratory fractionations but is not practical for industrial use. FLETCHER B. HOLMES of Woodbury, N. J. (Assignee E. I. du Pont de Nemours & Co.) has found that dinitrotoluol is a satisfactory extractor and patents its use.

Gasolene containing the aromatic hydrocarbons is mixed in any suitable manner with an equal weight of a nitro-compound—dinitrotoluol being preferable. This mixture, when allowed to stand, will separate into two layers. The lower layer is comprised mainly of a solution of aromatic hydrocarbons with some paraffines in the dinitrotoluol. The upper layer consists of a solution of dinitrotoluol and some aromatics in solution in gasoline. The two layers are separated and distilled, the higher boiling point nitro-compound being readily fractionated from each. The distillation is carried on preferably at a reduced pressure, or by injection

of a current of steam or other inert gas through the liquid; as the separation from the nitro-compound may be more readily effected in this manner. A distillate will thus be recovered from the lower layer having a higher aromatic concentration, while the one obtained from the upper layer will be decreased in aromatics. Upon repetition of the process, the lower layer fractions will increase in their toluol, benzol etc., content, while the upper will decrease in aromatic content until totally extracted. (Aug. 20, 1918; 1,276,219.)

MR. EDWARD A. BARNES of Giant, California, has received a patent on a process for directly nitrating the aromatics in the petroleum distillate. The light distillate is clarified by repeated agitation with 96 per cent sulphuric acid in the proportion of one gallon to the barrel of oil until all the fluorescent bitumens are extracted. The cleaned distillate is then mono-nitrated with a determined amount of a mixture of nitric and sulphuric acids at as low a temperature as possible, when all of the aromatic hydrocarbons are obtained as mono-nitro-derivatives. A mixture of 625 weights of 70 per cent HNO_3 and 325 weights of 96 per cent H_2SO_4 are slowly added in the form of an atomized spray to about 5000 weights of refined gasoline contained in a vessel provided with stirring devices and cooling coils. The temperature is kept as low as possible and agitation continued for four hours, after which the contents are allowed to separate. Three layers are formed, the top one being essentially paraffine oils, the second about one-tenth the bulk of the first consisting of nitro-aromatic hydrocarbons with a small paraffine content, and the third spent acids with not more than $\frac{1}{2}$ per cent of unused nitric acid—more than this amount indicating that too much mixed acid was used.

The mixture of nitro-aromatic hydrocarbons which represents 10 to 15 per cent of the original amount of distillate, dependent on the oil field from which it was derived, can be fractionally separated in any suitable still and condenser.

Furthermore, it is found that the complex mixture of mono-nitro-derivatives obtained in this process has the property of reducing the freezing point of nitroglycerin and that this property is also possessed by the mixture of di-nitro-derivatives obtained by re-nitrating the mixture of mono-nitro-derivatives with stronger acids at higher temperatures, and that all of these mixtures which range from liquids to solids are extremely suitable for employment in the manufacture of low freezing point explosives. The mixed acid employed for di-nitrating the mixture of mono-nitro-derivatives has a composition of 36 per cent HNO_3 , 62 per cent H_2SO_4 and 2 per cent H_2O ; the temperature of reaction is 170 deg. F. For tri-nitrating, the strongest acids obtainable are used; 93 per cent HNO_3 is mixed with oleum containing 20 per cent free SO_3 and the temperature is maintained between 210 and 260 deg. F. (July 23, 1918; 1,273,568.)

German Sugar Production, according to the *Kölnische Zeitung* is falling off from 28,000,000 tons of sugar beets in 1915 to 18,000,000, 1916; to 17,500,000, 1917. One-sixth of these figures gives the refined sugar tonnage.

Advance in Industrial Organic Chemistry Since the Beginning of the War*

A Review of the Expansion in American Organic Chemical Industries Since the War Began—Outlook for Future is Most Encouraging—Disturbed Trade Relations are Favorable to Establishing an Export Business

BY SAMUEL P. SADTLER, PH.D.

MANY ordinarily intelligent people with no special acquaintance with scientific matters will confess to having had the belief that the United States had no established chemical industries at the outbreak of the present great world war, or if we had any, they did not cover the field of what is known as organic chemistry. Organic chemistry was to them the field of coal-tar dyes and synthetic medicines. And was not this the peculiar and exclusive domain of the German chemical manufacturer? We rather think that this expresses the actual knowledge on the subject on the part of our non-scientific newspaper and magazine writers at the outbreak of the war.

However, the elements which go to favor the establishing of a chemical industry are a wealth of raw materials and a market for the manufactured product, and with these the coöperation of intelligent chemical effort and capital. All four of these elements existed in the United States and the result of their coöperation had already been quite effective long before the beginning of the war in giving us flourishing chemical industries based upon organic raw materials and involving applications of organic chemistry. When we recall the great wealth of this country in petroleum and asphalt, in all varieties of coal, in vegetable and animal oils and fats, in cereals of all kinds and in fibres of indispensable character, we would be surprised if flourishing chemical industries had not been established.

MAGNITUDE OF THE PETROLEUM AND OIL INDUSTRIES

Let us briefly view some of these industrial organic developments as they existed prior to 1914. The American petroleum industry easily ranked as the first in importance in supplying the world with the various products of mineral oil. Of a total annual world's production in 1914 of over 400,000,000 bbl., the United States produced 265,762,000 bbl. or just about two-thirds, while Russia, the next in rank, produced 67,000,000 bbl. or 16.7 per cent of the total amount.

But it is not only the raw material production that is to be considered. By far the larger proportion of this crude oil was refined in the United States and from it were made gasoline, kerosene, lubricating oils in great variety, paraffin and paraffin candles, vaseline and similar products. These products were not alone for the American market but went all over the world.

We also had a great and well developed industry in the extraction, refining and working up of vegetable and animal fats and oils. A peculiarly American industry was the cottonseed oil and cake industry. Hundreds

of mills throughout our Southern States were devoted to the crushing of the seed and the preparation of the cake, while the refining of the oil and the making of the finest edible products was carried out in large plants. The enormous production of lard and lard oil by our great packing companies and the preparation of oleo oil for foreign shipment was also an important and well established American industry. As a side product, the extraction and refining of glycerin had also become well established and the American soap industry was also well developed and a large export business already inaugurated.

The utilization of linseed oil for paint oils and in the manufacture of linoleum and oil cloth had also reached a high development at the hands of American technologists.

CORN PRODUCTS DISTINCTIVELY AMERICAN

The great naval stores industries involving the production and utilization of American turpentine and resin had also been well developed and many minor chemical industries based upon them. America was also one of the largest consumers in the world of rubber; thanks to the manufacture of all classes of rubber and water-proofed goods and to the utilization for automobile tires, the working of rubber had been extensively developed.

The refining of sugar, in part produced in the United States and the neighboring West Indies and in part from imported European raw beet sugar had become an extensive industry with the most modern of plant equipment and under scientific chemical control.

As America is in a large degree the granary of the world in its production of cereal foods, we had large chemical industries already occupied with the preparation of the special classes of food products of cereal origin. One of the best instances of a distinctively American industry developed from American material is the corn products industry. From the maize or Indian corn is produced corn starch for food purposes and for technical purposes, glucose or commercial dextrose, corn or maize oil and commercial dextrines. This industry has been developed from a distinctively American cereal and on lines quite peculiar to it as an industry of American growth.

Turning to the textile industries we have, as an American production, one of the world's most useful fibres, viz., the cotton fibre. I have already referred to its peculiar by-product, the cotton seed and its utilization. However, we have many important industries utilizing the cotton fibre in which its bleaching, dyeing and other treatment is chemically controlled.

The textile industries using wool and silk as well as

*A paper read at the Fourth National Exposition of Chemical Industries, New York, Sept. 28, 1918.

cotton have however attained a high development in the United States and the chemical side involving the cleansing and after treatment of the fibres had been thoroughly worked out.

The products of destructive distillation remain to be spoken of. Our American wood-distillation industry will be specially presented by another speaker during this Exposition and so I will pass this by. Coal distillation for gas-making had been practiced by the most accurate scientific methods and great varieties of special gas-making processes had been developed. It will be remembered that the Lowe water-gas process was an American invention which has been copied and adapted since in various other countries. However, we were slow to discard the old wasteful beehive oven for coking of coal for by-product ovens which collect the valuable residuals including gas, tar and ammonia. The production of coal-tar crude ingredients was therefore only moderately developed and of what we term the "intermediates" for the color industry, there was scarcely any production.

An American dye industry using imported intermediates therefore existed, but it existed under difficulty and played but a subordinate part in supplying the American market with the dyes required for our textile industries.

CAPITAL HAD NOT MADE THE ACQUAINTANCE OF THE CHEMIST

This brief survey shows that it is a great mistake to assume that there were no organic chemical industries existing in this country in 1914 at the outbreak of the war. Nevertheless the general public knew little of the chemist and his actual or potential value to industry or commerce. Capital, which frequently made large investments in mining and similar enterprises, many of which were largely speculative, had not made the acquaintance of the chemist to any notable extent perhaps because the language of chemical reactions was something foreign to his experience or training and hence distrusted. The war came and we soon learned how great a disturbance such a great war could be to the world's commerce in which the United States played a vitally important part. We also learned promptly how chemical industries were the foundation stones for this great commerce. It soon developed that war in its modern form was based upon the chemical activity and scientific development of a country and then the chemist began, as it has been repeatedly said, to come into his own.

Our special topic therefore is to briefly note how our American chemical industries, and in particular those involving organic chemistry, have responded to this war impulse and demand in the four years that have elapsed since the beginning of the war period in 1914.

Our petroleum industry, which we have shown was already in a highly developed state, had important problems at once presented to it. Great as was our refining capacity, it was utterly inadequate to produce in normal course the quantities of gasoline that were required. Besides the growing automobile consumption, the war demands for motor trucks and for aeroplane and tractor engines came as an added load on the industry. Because of the demoralization of the Russian oil production and the German occupation of Roumania,

the whole gasoline supply for the allied nations has to come from America. To meet this demand we have in addition to what may be called "straight refinery" gasoline, blended "casing head" gasoline and "cracked" gasoline. Under the pressure of the great demand, large quantities of volatile hydrocarbons are washed out by suitable solvents or condensed out of natural gas and then blended with heavy naphtha to bring down the gravity to a proper average. Such a gasoline will necessarily have a wide volatility range but is available for most uses of the normal refinery gasoline. Most of the areas producing natural gas are available for this gasoline extraction but it has developed particularly in West Virginia, in Oklahoma and in California. It is furnishing a rapidly increasing amount of gasoline yearly.

The third source of gasoline mentioned is from special cracking processes and it is this class of processes which has been attracting the most interest and giving the greatest promise of large results. The whole subject was discussed from a theoretical and historical point of view in *Bulletin 114* of the Bureau of Mines by Rittman, Dutton and Dean. Since the date of that publication in 1916, a great deal additional has been published in the journals and much has been done in a practical way. The Burton process adopted by the Standard Oil Co. is now in operation on a large scale in several of the largest refineries of that company; the Rittman process has been tried on a working scale, although not yet developed to a final form for large-scale production; the McAfee process of decomposition in the presence of aluminium chloride as a catalyst has been developed by the Gulf Refining Co. and the Snelling process has also been brought forward.

That heavy petroleum oils can be cracked so as to produce much light oil or gasoline is beyond question, but the problem is to avoid the production of large proportions of unsaturated hydrocarbons which require acid treatment in the product. McAfee claims to avoid this production of unsaturated compounds and that his gasoline requires no acid treatment, but the success of his process is conditioned on the economical recovery of the anhydrous aluminium chloride available for use. Enormous quantities of other special petroleum products have also been called for by reason of war demands, such as high-grade lubricating oils. I had brought to me for testing some time back a "recoil oil," required by the Government for use with heavy guns, that with a high viscosity had to stand a cold test of — 5 deg. F. (— 20 deg. C.).

Then the demands of the English and the U. S. Navy for fuel oil have drawn upon the Mexican oil fields as well as those of Louisiana and Texas and have pushed production to the maximum.

Meanwhile a new raw material has been brought to notice that is capable of adding enormously to our available petroleum supplies in the oil shales of Western Colorado and Eastern Utah, the deposits also being found to some extent in Nevada, Wyoming and Montana. These shales readily yield by distillation a crude oil capable of furnishing gasoline, kerosene and paraffin and in addition large amounts of ammonia, so that sulphate of ammonia may be obtained as a by-product. In *Bulletin 691B* of the U. S. Geological Survey, D. E. Winchester has described this occurrence and gives records of distillation. These shales are said to be like

the Scotch shales but richer in oil. With the gradual exhaustion of the oil fields they will prove a welcome addition.

VAST INCREASE IN OIL PRODUCTION AND IMPORTATION

The vegetable and animal oil markets have been greatly affected by the war and the industries based upon them have been changed in a revolutionary way in many cases. The first cause may be said to have been the export embargo established by Great Britain upon all glycerine-containing oils with the beginning of the war. Following this came a shortage in the cotton seed crop in 1915 and the introduction of Soya bean culture in the South. As the refined cottonseed oil took more and more the position of an edible oil, commanding correspondingly higher prices. The Soya bean oil took its place for industrial uses, for soap and paint manufacturers and as a constituent of compound lard and oleomargarine. Soya bean cake has also been readily taken up for stock feed and for fertilizer. The Soya bean contains more protein than either cotton seed or peanuts, as much fat as cotton seed, and only one-fourth as much fibre as cotton seed or peanuts.

It has a lower iodine number than linseed oil and is slow in drying, so that it can not completely replace linseed oil in the paint industry but can be admixed with it. Besides the production in the South, which according to Government reports in the year 1917 was from 531,000 acres, we have had an enormous development of the Soya bean oil importations as the following figures will show. Importation for year 1914, 12,500,000 pounds, for 1917, 264,900,000 pounds and for 1918, 336,824,646 pounds.

Most of this coming from Manchuria enters Seattle and other Pacific coast ports. All available storage facilities at Seattle and other coast points have been overtaxed in the handling of this supply.

HYDROGENATION GIVES OILS AN ADDED VALUE

Another great development in oil supplies has come from the greatly increased production of peanut oil. This has come to the fore as a salad oil and for soap making. The crop in the United States rose from 3½ million bushels before the war to 40 million bushels in 1916. For 1917, the Government reports shows that 3,277,000 acres were devoted to its culture in the South, and for the year of 1918 it is estimated that in the State of Texas alone 3,000,000 acres will be devoted to it. The importations have also increased sixfold since 1914, now amounting to over 8 million gallons.

A year ago we had no castor beans grown in this country to speak of. Today we have at Government instigation hundreds of thousands of acres devoted to it in Florida and elsewhere, with the product contracted for by the Government. As illustrating the greatly increased demand for oils capable of yielding food products we may also note the remarkable growth in the cocoanut oil and copra importations. In 1914 the importations of cocoanut oil amounted to 74,386,213 lb., in 1918 it had grown to 289,194,853 lb.; of copra for the expressing of cocoanut oil we imported 45,437,155 lb. in 1914 and in 1918, 486,996,112 lb. Similar changes have taken place in the fish-oil markets with the decrease in the menhaden catch, due to the commandeering of fishing boats and scarcity of men to man

them. Through our Pacific ports chiefly are imported quantities of dog-fish, halibut, salmon, sardine, shark, tuna-fish, candle-fish and walrus oils, largely new to the market, while whale oil, seal oil and porpoise oils are again appearing in large quantities. These fish oils have moreover an added value as sources of supply since the general application of the hydrogenation process, whereby they can be changed into hardened fats without offensive odor and of the greatest value as soap stock and for glycerin production.

GLYCERINE AND OILS FOR EXPLOSIVES

With regard to the increased production of glycerine because of the war demand, I have no figures, but it has been very great, so that the use of glycerine in pharmaceutical preparations has been discouraged in order to conserve the glycerine for nitroglycerine production and for export to our allies. About 21 million pounds has been exported in 1918.

In the field of essential oils there are a few items of interest to note. With the study of wood turpentine as distinguished from gum turpentine it has been recognized that spruce-wood turpentine, now a waste product of the sulphite process of making paper pulp, has a peculiar composition. It consists largely of one aromatic hydrocarbon, cymene (iso-propyl-methyl-benzene). On subjecting this to the Friedel and Crafts reaction with aluminium chloride in the presence of an excess of benzene, toluene and cumene (propylbenzene) are formed. The toluene is readily converted into TNT (trinitrotoluene) and the cumene may be oxidized directly into benzoic acid. The work as reported in the *Journal of Industrial and Engineering Chemistry* for May, 1916, is still in a purely experimental stage but it has much promise.

One of the newer uses of essential oils which has particularly stimulated the production in the last few years of pine oil in the South is for the ore flotation process. The concentration of both copper and zinc ores in the United States as in other parts of the world is now effected by agitating the finely pulverized ore with water in the presence of a small quantity of oil. While fatty oils, mineral oils, coal-tar and wood-tar creosotes have been used, certain essential oils have been found to be specially adapted for this treatment. In this country pine oils, both steam-distilled and destructively-distilled have been especially used and quite an industry in these oils has developed. The magnitude of our copper and zinc production is such that although the amount of oil used in this flotation process is relatively small (less than 1 per cent on the ore) the aggregate consumption of oil is very large.

The war demand has greatly increased the call for rubber goods of all kinds, especially automobile tires, and consequently the consumption of crude rubber has grown rapidly. The importations of rubber in 1914 amounted to 132 million pounds but grew to 390 million pounds in 1918. Exports of rubber boots and shoes were valued at \$1,113,495 for 1914 and \$5,774,341 in 1918; the automobile tire exports were valued at \$4,068,639 in 1914 and \$15,128,294 in 1918.

VARIED USES OF ORGANIC SOLVENTS

In this connection reference may be made to the greatly increased demand for organic solvents and the

work done to meet this demand. The most important work of this kind is probably the production of acetone and similar solvents from the Pacific Coast kelp by the Hercules Powder Co. and this fortunately we will have specially presented at this time in a paper dealing fully with the subject.

Another promising line is the manufacture of amyl acetate from petroleum pentane recently described in the *Journal of Industrial and Engineering Chemistry* for July, 1918. This work has been carried out at the Mellon Institute in Pittsburgh, Pa. The use of these organic solvents is manifold but we may note the extensive use of pyroxyline solvents and the greatly increased use of lacquers of this description in the last four years. From aeroplane wing dope to artificial leather we have a variety of utilizations; some of these have grown to extensive industries within the past few years.

Closely allied with this industry is the artificial silk industry, one variety of which is made from a nitrated cotton or pyroxylin. Besides this variety we have the viscose variety, the cellulose acetate, and the cuprammonium artificial silk. The development of these products has been very great in this country in recent years, both for films and for artificial silk as a fibre increasingly used in the textile trade.

Industrial alcohol production has developed greatly in the past few years and numerous new plants have been established for its production from a variety of sources. Much attention has been given to a revival of the Classen process for hydrolyzing the cellulose of sawdust and fermenting the sugar produced therefrom. I have no reliable information however as to whether the difficulties which developed when it was first tried in this country some years ago have been sufficiently overcome to make it a dependable manufacturing process although it has attracted much newspaper attention. More reliable are the processes based upon the use of low-grade molasses and cereals of various kinds and a large production, at present taken over by the munition manufacturers, has been the result.

In addition to this direct war use much alcohol is made for denaturing and use in the manufacture of pharmaceutical products. Some 27 denaturing formulas have been allowed by the U. S. Internal Revenue office and these adapt it for use in a wide variety of cases where tax-paid pure alcohol is inadmissible on account of its cost. This form of utilization is not of temporary character as is the use in munitions manufacture but is destined to grow and require an increasing amount of alcohol properly denatured.

GREAT DEVELOPMENT OF THE DYE INDUSTRY

We come now to the industry which may be said to be the touchstone of our ability to achieve results under difficult conditions when confronted with an imperative necessity, viz., the building up on American soil from American raw materials with American capital and American chemical effort an independent dyestuff industry. In speaking of the conditions in the United States in 1914, I said that we had a small dyestuff industry, working under trade difficulties; for the most part with imported intermediates. There were, to be exact, five manufacturers, large and small, of dyestuffs in 1914. The tariff census of coal-tar products, as re-

ported for 1917, shows that there were at that time in the United States 81 establishments engaged in the manufacture of coal-tar dyes and 117 firms manufacturing intermediates. While these figures are striking and can not fail to arrest attention, it is only when we look more fully into the details that we get an adequate understanding of the great industrial achievement that has been wrought in the last four years.

First, as to our dependence upon foreign sources, chiefly German, for our dyestuffs at the beginning of the war in 1914. We were then making in this country a bare one-fifth of our needs out of foreign materials and had neither crudes nor intermediates to speak of. Dye imports from Germany in 1914 were valued at \$5,965,537; in 1916 they were valued at \$849, in 1917 \$464,499, and in 1918 at \$3048. The relatively large amount for 1917 represents shipments held at first in Great Britain but released later on appeal. Do we still import any dyestuffs? Yes. There are two reasons for importing from Switzerland and Great Britain mainly certain dye colors.

The new American dye industry did not at once attempt to duplicate the 900 or more supposedly distinct synthetic dyes of the German dealers but took up the most important classes and produced a moderate number of representative dyes, covering as far as possible the coloring or tinctorial needs of the textile trade. Some of the finer shades are still missing, hence the Swiss importations.

The other reason and perhaps the more important one was that Congress, in the enactment of our present tariff law, cut off the ad valorem duty on indigo and alizarine products, which caused manufacturers to leave the production of these very important products until they had covered the need in other groups more fully.

However, synthetic indigo of American manufacture is already on the market and there will be three sources of supply for it in 1918, one of which promises to supply at least one-half of what the American trade will need for the year. Similarly artificial alizarine of American manufacture, made in Brooklyn, in fact, will be available in large quantities from this time on.

Meanwhile approximately three-fourths of the dyestuffs needed are being produced and some colors in such quantity that an export trade has been started. Let us note that for the year ending June, 1916, the exports of all varieties of dyestuffs—aniline dyes, logwood extract and all other—totalled \$5,102,002 in value, but the bulk of these were vegetable colors including logwood extract. In 1917, the valuation of the exports had leaped to \$11,709,287, with an increasing amount of such colors as sulphur black and the simpler aniline colors. In 1918, and this shows the quality as well as quantity of development, the total exports of dyestuffs were valued at \$16,921,888. Of this, total aniline colors make \$7,298,298, logwood extract \$2,339,480 and all other \$7,284,110. It will be noted that the aniline colors alone exceeded in value the dyestuff importations from Germany in 1914.

HOW DOMESTIC SHORTAGE WAS RELIEVED

But the main market for which these dyes are being made, and for the permanent relief of which a great American industry has been created is the United States market and the way in which this has been done

is deserving of a more completely detailed examination.

With the shutting off of the foreign sources of supply in 1914, not only was the need of an American dye industry made clear, but the manufacture of munitions and the filling of foreign orders called for coal-tar products. The manufacture of phenol or picric acid and of trinitrotoluol all demanded an immediate supply of coal-tar crudes. So the gas works, the by-product coke ovens and the tar distillers all united for increased and intensive production. I need only refer to the lists of such great companies as the Semet-Solvay Co., the United Gas Improvement Co., and the Barrett Manufacturing Co. as illustrating the achievements in this production of coal-tar crudes. For the increased production of benzol and toluol the Ordnance Division of the War Department has also started to establish plants for by-product coal distillation because of its special needs.

However, for the dyestuff manufacture we go from the coal-tar crudes to the "intermediates." Some of these require very special apparatus for their manufacture and it was these that had not been made in this country prior to 1914. Our chemical apparatus manufacturers (several of whom are very well represented in this Exposition) responded to the call for this apparatus and gradually these important products, mostly new to American trade, were supplied. The tariff census of 1917 states that the production of intermediates for that year was contributed to by 117 firms and that the production amounted to 322,650,531 pounds valued at \$106,942,918. These figures however involve considerable duplication because of the use of some as a starting point in making others. That the amounts of many are very large is shown however by the statement published by the National Aniline and Chemical Co. that their Marcus Hook works has a producing capacity of aniline oil five times as great as the total consumption in this country prior to the war, and that this company is now the largest producer of aniline oil in the world.

Of course the manufacture of munitions, begun on Allied account and continued later by the Ordnance bureau on our own account, means the production of numerous organic compounds on a scale totally beyond any previous experience—picric acid, trinitrotoluol, nitrocellulose and nitroglycerine for smokeless powder, fulminate powders and other preparations are manufactured by tons, but as this is a war industry and not one that will continue we have omitted it from our discussion.

In conclusion, what is the outlook for industrial organic chemistry in the immediate future in this country? I would say that it is most encouraging. The exigencies of the war in Europe have caused a widespread search for independent sources of raw materials to be made and with very satisfactory results in many cases. Our large corporations have established research laboratories with the best up-to-date equipment and have planned real and thorough-going research in a broad intelligent spirit which does not ask for hasty results but emphasizes the wish for thoroughness. Our Government has recognized in a very satisfactory way its need of chemical service and has thus publicly endorsed the fundamental importance of the chemist in industrial achievement. Capital has come forward willingly in support of properly planned

chemical undertakings and thus made the establishment of new industries possible in a way far beyond what had been possible before the war period. Lastly, the disturbed condition of all European trade relations has made it possible for the United States to inaugurate very promising export business in quarters not previously practical or under conditions formerly distinctly unfavorable. These new achievements we have every reason to expect to continue in future and no doubt with added momentum.

Charging Tar in Gas Producer

A new method of enriching producer gas contained in a description of the "Gasteam Plant at Ford City, Ontario" appearing in *Power* for Aug. 6, 1918, is an account of their success in returning tar recovered in their gas cleaning system to the producer for gasification. At this plant are installed two Smith gas producers, each built in six independently controlled sections, and with a total capacity of 100 tons in 24 hours. This gas producer has an incline grate with a heavy clinker bar at the toe of the slope, all of the grate bars being operated by compressed air. Each section is charged mechanically through an air lock at the top of the fuel bed, which latter is normally at a dark cherry-red heat and maintained at a depth of 5 feet at the top and 7 feet at the bottom of the slope. Exhaust steam is blown under the grate bars, thermostatically controlled so as to regulate the temperature of the blast at 120 deg. F.; too cool and dry a blast means hard clinker, while too hot a blast gives CO₂ in the gas. The steam is blown into the producer in puffs, two per minute, so that the action somewhat simulates that of the Mond.

Each producer has its own gas-cleaning system in which the hot, dirty gas is first scrubbed in a primary cooling tower which reduces its temperature from 1100 to 120 deg. F. An exhauster, displacing 45 cu.ft. per rotation, delivers the cool gas under 3 pounds pressure to a series of seven tar extractors. These consist of 1½ pounds of spun glass-wool made into a diaphragm through which the gas passes at high velocity, leaving behind its tarry matters which agglomerate into drops and fall into a drain leading to a storage tank.

The stored tar is delivered to five sprays above each fuel bed through a 2-inch line, unjacketed, being blown out of the tank by 880-pound steam. This method is superior to pumping, since the steam blows out the entire system when it is empty, obviating any danger of plugging with solidified tar. About 950 gallons of tar are produced and consumed daily. Little trouble is had if the tar is sprayed evenly over a compact fuel bed running steadily at a temperature between 1000 and 1200 deg. F. Too high a temperature produces fine lamp black which clogs the cleaning system, while if the fuel bed is too cool, the liquid saturates the interstices. The use of the tar reduces the hydrogen and increases the methane content of the gas; it also betters the thermal efficiency of the producer from 8 to 9 per cent. Analyses of typical gases follow:

	No Tar on Bed		Tar on Bed
	28 Per Cent Ash in Coal	12 Per Cent Ash in Coal	12 Per Cent Ash in Coal
CO ₂	4.7	3.8	4.7
CO.....	23.9	23.3	22.1
O ₂	0.5	0.5	0.5
H ₂	15.3	12.7	6.2
CH ₄	2.3	5.1	10.5
B.t.u. per cu.ft.....	161.0	179.0	208.0



The Electrochemical Industries at Shawinigan Falls

Description of the Development of Over Three Hundred Thousand Horsepower and of the Varied Industries Attracted by This Resource—Conditions are Favorable for Labor, Raw Materials and Transportation

By HENRY C. RANDALL

SHAWINIGAN FALLS is located in the Province of Quebec, Canada, midway between Montreal and Quebec City, and derives its name from the Indian word indicating the resemblance between their beautiful quill and bead work and the great falls of the St. Maurice River. The city is of comparatively recent origin, having been until 1898 a wilderness, many miles from the nearest railroad. That year marked the commencement of the development of power at the falls of the St. Maurice River, which are 150 feet high at this point and offer what is perhaps the most remarkable natural power development in the world.

Since 1900 the growth of the city has been extremely rapid because with the coming of the Canadian Northern Railway and the Canadian Pacific Railway the products of immense electrochemical plants, which could obtain cheap power near the falls, were able to cheaply reach the world's markets. Twenty miles below Shawinigan Falls lies Three Rivers, at which point the St. Maurice River enters the St. Lawrence River. Three Rivers is on tidewater, and with its many miles of docks, capable of docking any vessel navigating the St. Lawrence River, is in a position to furnish a remarkably satisfactory export shipping port for the industries which have grown up at Shawinigan Falls.

POWER SUPPLY

The basis for the electrochemical developments at Shawinigan Falls is, of course, the large amount of hydro-electric power which is available at remarkably low prices. The Shawinigan Water & Power Company, which owns the power developments at this point, has at present installed in its generating stations at Shawinigan Falls and Grand'Mere, Que., 330,000 horsepower, of which 265,000 is electric power, the balance of 65,000 being sold as hydraulic power to certain of the local industries at Shawinigan Falls.

While this amount of power is capable of supplying all of the present requirements of the district, the Shawinigan company further owns the Gres Falls, six miles below Shawinigan Falls on the same river,

at which point 75,000 horsepower can be developed as soon as required. Moreover, at Grand'Mere, nine miles above Shawinigan Falls, provision has been made for the addition of 60,000 horsepower, and as the foundations have been prepared for this additional capacity, it could be obtained upon relatively short notice. The electrochemical industries at Shawinigan Falls are, therefore, assured of an abundance of hydro-electric power, not only for today, but for a considerable time in the future.

SHIPPING CONDITIONS

Shawinigan Falls is served by two railroads, the Canadian Northern Railway and the Canadian Pacific Railway, both of which make connection with the National Transcontinental Railway a few miles from Shawinigan Falls. All switching to the various industrial plants is done by the Shawinigan Falls Terminal Railway, so that switching is conveniently and cheaply obtained and the facilities of each railway equally placed before all of the industries.

Three Rivers, twenty miles from Shawinigan Falls, is situated on tidewater, and will offer after the war, when shipping restrictions are reduced, an ideal export shipping port for seven months in the year. During the winter months when the St. Lawrence River is frozen over, export shipments are made from St. John or Halifax.

Three Rivers also offers an ideal shipping port for serving the Great Lakes trade, so that, especially in summer, Shawinigan Falls industries are placed very advantageously with respect to ocean and lake shipping.

While it is difficult to discuss export shipping rates at the present time, it is nevertheless true that in normal times, averaging a large number of the ordinary heavier electrochemical products, a differential of \$2 per ton exists in favor of Shawinigan Falls in summer, and \$1 per ton in winter, over Niagara Falls, which city is taken as representing the greatest electrochemical center on the continent. These differentials will, of course, only apply to products which can be exported to ports reached by the Canadian sailings,



FIGS. 1 TO 8.

Fig. 1—Canadian Electrode Co. Plant. Fig. 2—Shawinigan Electro Metals Co. Plant. Fig. 3—The Northern Aluminum Co., Ltd., Plant. Fig. 4—Canadian Ferro-Alloys, Ltd., Plant. Fig. 5—Shawinigan Developments. Fig. 6—Canadian Aloxite Co. Plant. Fig. 7—Canada Carbide Co. Plant. Fig. 8—Prest-o-lite Co. Plant.

which in general are satisfactory for supplying the European trade. If products are destined for ports not reached by Canadian sailings, it will in general be cheaper to use New York as a shipping point, in which case a differential of between \$1 and \$2 per ton exists in favor of Niagara Falls.

RAW MATERIALS

Bituminous coal in normal times is obtained from Nova Scotia, costing normally (pre-war) \$3.20 per ton on wharves at Three Rivers. Anthracite coal is



VIEW OF PORTION OF CHEMICAL SECTION

obtained from United States coal fields. Coke to the amount of about 200,000 tons per year is made at Montreal, largely from West Virginia coal, and can be obtained at very favorable prices.

Petroleum coke to the amount of about 5000 tons per year is manufactured at Montreal, about one-half being made from mid-continent crude-oil and the balance from Mexican crude oil.

Tar to the amount of 3,000,000 gallons per year is produced by the Montreal Gas Company, which is refined and from which 15,000 tons of pitch per year is available.

High grade limestone, quartz and sandstone are available in large quantities near the St. Maurice Valley. Chromium and titanium ores are found and mined commercially within one hundred miles of Shawinigan Falls, as well as zinc, magnesite and other minerals. Excellent shipping and railroad facilities, putting Three Rivers and Shawinigan Falls in touch with the world, make the supply of those raw materials required for particular processes a relatively easy problem for the manufacturer.

LABOR CONDITIONS

The St. Maurice Valley is essentially an agricultural community, and as it is largely populated with the thrifty and home-loving French race, there is available on the markets of the industrial centers food products at very fair prices, which is an essential condition in maintaining stable labor conditions. The large families which are common in the Province furnish practically all of the labor required in the industrial centers, and this labor, being French and thrifty, settles down and readily becomes a permanent part of an industrial community.

The amount of labor available in the Province is very

large and is of the kind adapted to industrial work, to which statement the large New England industrial centers of Manchester, Fall River and Lawrence bear witness, as the population of these cities is largely made up of French-Canadian people from the Province of Quebec. It is remarkable that in spite of present-day conditions no strikes or other great evidences of labor unrest have ever been found in the Shawinigan Falls-Three Rivers district. The natural traits of the French people, their thrift and frugality, make labor conditions in the St. Maurice Valley exceptionally satisfactory to the manufacturer.

GROWTH OF SHAWINIGAN FALLS

The first electrochemical industry to establish itself at Shawinigan Falls was the Pittsburgh Reduction Company, now the Northern Aluminum Company. Soon afterwards the Canada Carbide Company was started, and in 1905 the Belgo-Canadian Pulp & Paper Company built their first mill. These industries expanded rapidly to many times their original proportions, but no other industries were established at Shawinigan Falls until 1914.

During this period a very large market for the power generated by the Shawinigan Water & Power Company was built up throughout the Province of Quebec, transmission lines being built to serve all the larger cities of the Province and over a hundred of the smaller towns. In 1915, however, a very large addition to the generating capacity of the Shawinigan Company was completed, and this, with the great demand for power existing throughout the country and the inability of manufacturers to obtain power, made the growth of Shawinigan Falls extremely rapid from that time on.

The population of Shawinigan Falls in 1912 was about 8,000; in 1918 its population had increased to



FRASER BRACE CO.'S ELECTRIC FURNACE PLANT

14,000. This great increase in population was brought about by the influx of labor from the surrounding territory for the new electrochemical plants constructed since 1915, descriptions of which are given below.

The Northern Aluminum Company is located outside of the electrochemical district but adjacent to the power developments of the Shawinigan Company. This location was chosen on account of the fact that the Aluminum Company utilizes hydraulic power for their

works rather than the electric power of the Shawinigan Company, although a considerable amount of electric power is now purchased by them.

Their works, of an extensive nature, cover about fifteen acres of ground and contain, beside the reduction rooms for the production of aluminium, an ingot room and a rolling mill and a wire-drawing and cabling plant.

The Canada Carbide Company occupies some fifteen acres of land in the industrial district. The company



GRES FALLS

employs some 500 men and manufactures calcium carbide and acetylene gas only and utilizes about 50,000 horsepower.

The Shawinigan Electro Metals Company, whose plant was constructed and put into operation in 1915, produces metallic magnesium in many forms and occupies about five acres with their various processes. They utilize about 2500 hp. in both alternating and direct-current furnaces.

The first plant of the Canadian Electrode Company was constructed in 1915, but since that time two additions to the plant have been made, so that the present capacity is about four times the original capacity. This company manufactures the larger sizes of carbon electrodes for electric furnaces and have an output of about 30 tons per day. The majority of the output is used in Shawinigan Falls, although a considerable tonnage is exported.

The Canadian Electro Products Company manufacture acetic acid, acetaldehyde, paraldehyde, acetone and other similar products from acetylene gas supplied by the Canada Carbide Company. This plant, while primarily constructed for the purpose of supplying acetone and acetic acid to the British Government, has so demonstrated its possibilities that it will continue to be one of the most important industries at Shawinigan Falls when the war is over.

The Prest-o-lite Company constructed in 1917 a plant for compressing acetylene gas for charging Prest-o-lite cylinders. This gas is purchased from the Canada Carbide Company, near whose plant the Prest-o-lite works are located.

Fraser, Brace & Company in 1917 erected a small electric furnace plant of about 1000 hp. for the manufacture of low-phosphorus pig iron. This plant has been very successful and is now being expanded into a considerably larger industry.

In 1917 the Canadian Aloxite Company, a subsidiary of the Carbide Company, erected a plant covering about

fifteen acres of land near the upper end of the electrochemical district. In these works the company utilizes over 20,000 hp. for the production of such electric furnace products as aloxite, carborundum and ferro-silicon.

During the summer of 1918 the requirements of the United States Government for acetic acid led to the establishment of a plant practically duplicating the Canadian Electro Products Company's plant and erected adjacent to the same. This plant, owned by the American Electro Products Company, will be operated by the Canadian Electro Products Company for the production of these products on behalf of the United States Government.

The latest addition to the Shawinigan electrochemical district is the Canadian Ferro-Alloys, Limited, who have constructed a plant near the Canada Carbide Company for the manufacture of ferrosilicon, and utilize some 10,000 hp. for this purpose.

While not electrochemical, two industries in the Shawinigan district are worthy of mention on account of the large amount of power they consume—the Laurentide Company at Grand'Mere utilizing 28,000 hp. for the manufacture of paper and pulp, and the Belgo-Canadian Company at Shawinigan Falls utilizing 18,000 hp. for the same purpose.

GENERAL CONDITIONS

The St. Lawrence Valley being tempered by the large mass of water moving from the Great Lakes to the sea has a very steady and pleasant climate. The Shawinigan district has a mean annual temperature of about 50 deg. Fahrenheit, the days being hot in summer but the nights cool. The winters are rather long and cold but the air is dry and great variations in temperature do not take place rapidly, so that to many the winter season is the most enjoyable of all the year.

Shawinigan Falls, like other large, rapidly growing communities, is somewhat hampered at the moment by



THE CANADIAN ELECTRO PRODUCTS CO.

the lack of housing facilities, but houses are being built rapidly and will no doubt keep pace with the increasing population. As an indication of the stability of the labor, it may be noted that a great number of the houses in Shawinigan Falls are owned by the workmen themselves.

There is a Technical Institute in the city having some 150 students and equipped with fine modern laboratories housed in modern buildings. This institute offers a means of education to the younger men in order that they may be better fitted for the industries.

existing in the community, and its night courses, which are well attended, aid workmen to become more useful and to become foremen and superintendents.

As the community is quite new, large amounts of land are available for industries, and in general, sites may be found lying between the two railroads so that siding facilities may be had on each. There is no difficulty



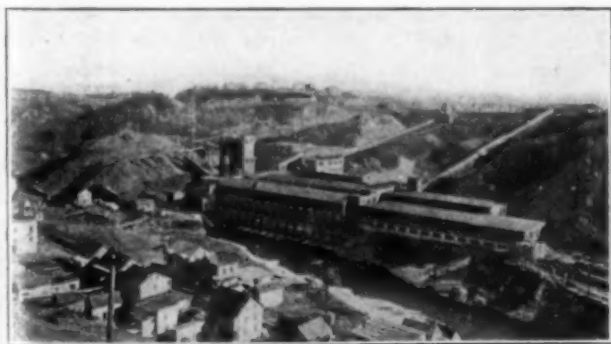
LAURENTIDE POWER HOUSE

in obtaining water from the river for industrial purposes, and this water is of such character that it can be used for the majority of industrial works.

The St. Maurice River water is not used for drinking purposes below Shawinigan Falls, and as the salt sea water is met a few miles below Three Rivers, very little, if any, objection can exist to stream pollution from industrial plants.

SHAWINIGAN FALLS—THE ELECTROCHEMICAL CENTER OF CANADA

If we examine the reasons which have made Shawinigan Falls such an important electrochemical and in-



BELGO CANADIAN PULP AND PAPER CO.

dustrial center, we find that they may be summarized as follows:

1. Large amount of power actually available at low prices.
2. Cheap labor of a very satisfactory character.
3. Low import rates for ocean-borne materials.
4. Low export freight rates.
5. Reasonable coal costs.
6. Raw materials near at hand.

These influences, which have built up the Shawinigan Falls of today, will be just as active in the future, and as a result the number and size of the electrochemical industries at Shawinigan Falls must increase rapidly. With 100,000 hp. now available as fast as

plants can be erected to utilize it, and with several hundred thousand horsepower yet untouched, the district offers a strategic location for serving the export market, the future basis of business.

At the present time, Shawinigan Falls is one of the few localities in the country where power in quantity can be obtained quickly and cheaply, and where the necessary labor for plant operation can be obtained without excessive importation. With these present advantages and future possibilities, the Shawinigan Falls of the future will doubtless continue to be the electrochemical center of Canada, if not of North America.

Montreal, Canada.

Doping in Aircraft Works

The annual report of the Chief Inspector of Factories and Workshops for 1917 [Cd. 9108, 3d] contains a special report on "Doping in Aircraft Works" by Mr. S. Smith, Dangerous Trades Inspector, of which the following is an abstract:

During the period in which dopes containing tetrachlorethane were in use 70 cases of toxic jaundice, including 12 deaths, were reported. A standard of ventilation for dope rooms of 30 changes of air per hour was adopted with good results, but in September, 1916, the use of tetrachlorethane was discontinued. The new dopes containing acetone (diethyl ketone), acetone substitutes (impure mixtures of dimethyl ketone, methyl ethyl ketone and higher homologues), and benzol, also the varnishes containing amyl acetate, still gave trouble as regards nauseating smells, and it was found necessary to maintain the same high standard of ventilation as before. Complaints have been received that where the dopes were used intermittently without mechanical ventilation, the effects from the fumes were more noticeable than those from the older poisonous dopes, and this is especially true where large aëroplanes have their fuselage doped in the erecting shops where no system of artificial ventilation can be applied. As far as possible the fuselage components are being doped before assembly, in properly ventilated rooms, as in the case of wings and planes. The use of sprays instead of brushes gives rise to excessive fumes and mists, so that it is still more necessary in such cases to have efficient ventilation.

Asphodel as a Source of Alcohol

Aphodelus ramosus, which contains much starch in its tubers, grows as a common weed (porrazzo) in many parts of Italy; in fact, it has been called "the plague of the Mediterranean." At one time it was cultivated as a source of industrial spirit, but, owing to difficulties in the rectification, the culture was abandoned. If these difficulties could be overcome Italy would be able to considerably increase her home supply of spirit, for it is claimed that every acre of asphodel plants yields 17,850 lb. of roots from which not less than 107 gallons of alcohol could be obtained. When the manufacture of porrazzo was carried out in Algiers the residue from the distillation was used successfully in the production of paper, but it could also be used directly as a cattle food. —(Annal. d'Ingegn. e d'Archit.)

Alcohol in the Arts and Industries

Government Restrictions Surrounding the Manufacture and Sale of Alcohol Restrict Its Legitimate Uses in Industry—a Brief Review of the Wide Use of Alcohol

By E. H. LESLIE, Ph.D.

TWENTY years ago a joint select committee of the Congress of the United States submitted the following statement as part of an official report:

The uses of alcohol other than as a beverage are more largely and widely extended than is supposed. But while the use of alcohol as a beverage is purely voluntary, its employment for all other purposes is legitimate, beneficial, and necessary. No article entering into manufacture or the arts, whether of domestic or foreign production, performs more legitimate or beneficial functions. There is scarcely a manufacturer in the country who does not use alcohol in the production of his goods to a greater or less extent.

Since that statement was made, its force has been many times multiplied. A large number of new uses have been found for the commodity, and a variety of new products have been produced in the manufacture of which alcohol is a necessity. Industrial alcohol is now produced in large and ever-increasing quantities. Table I, taken from the report of the Commissioner of Internal revenue for the fiscal year ending June 30, 1917, shows the rapid increase in the production of industrial alcohol of denatured grades.

TABLE I—PRODUCTION OF DENATURED ALCOHOL

Fiscal Year	Number of Denaturing Warehouses	U. S. Gallons, 90 to 95 Per Cent Alcohol
1907	8	1,780,276.35
1908	12	3,321,451.73
1909	12	4,556,418.85
1910	12	6,079,027.10
1911	14	6,881,129.86
1912	14	8,094,515.00
1913	21	9,831,658.54
1914	25	10,404,975.59
1915	23	13,986,468.77
1916	33	46,679,106.38
1917	44	55,679,597.63

In addition to the denatured alcohol recorded in this table, a considerable quantity of tax-paid 95 per cent alcohol is consumed for industrial purposes. The quantity of alcohol so used is estimated at 4,200,000 U. S. gallons. The total amount of industrial alcohol consumed in this country therefore approximates 60,000,000 U. S. gallons.

The entrance of the United States into the war, and the necessity for the conservation of food materials brought about thereby resulted in the passage on August 10, 1917, of an Act of Congress prohibiting the manufacture of beverage alcohol from foods, fruits, food materials and feeds. The importation of beverage alcohol into the United States is also prohibited. Industrial alcohol is therefore at present alone in the field.

GOVERNMENT REGULATIONS HAMPER INDUSTRY

The war has brought about no radical changes in the industry of industrial alcohol other than to increase the production for war purposes. The Government rules and regulations surrounding the manufacture, sale, and distribution of alcohol still remains

a source of expense and difficulty to the manufacturer and the consumer. The new revenue laws have still further complicated the sale and distribution of domestic alcohol so that today it is difficult if not impossible to purchase a small quantity of the pure commodity for legitimate household use.

The existing regulations governing the manufacture of industrial alcohol are the outgrowth of the moonshine whiskey days. They were designed to curb the illegal activities of numerous small operators. Time has modified these regulations somewhat, but the producers of industrial alcohol today find themselves still surrounded and hindered in the operation of their plants by a host of antiquated rules. The passage of the recent emergency measure prohibiting the manufacture of alcoholic beverages taken in consideration with the probability that this law will continue in force after the war makes the present an appropriate time for a reconsideration of the rules and regulations which hamper the production of industrial alcohol.

USES OF ALCOHOL IN THE ARTS AND INDUSTRIES

It is scarcely fitting in these days to go into detail on the subject of the relation of the alcohol industry to the war or the uses of alcohol in warfare, though these are matters of considerable interest. It is believed, however, that a brief review of the uses of alcohol in the arts and industries may be of value at this time when at the Fourth National Exhibition of Chemical Industries each and every chemical industry is passing in review before the public eye.

The uses of alcohol may be more or less arbitrarily classified into five groups as follows:

1. Fuel.
2. Raw Material in Chemical Processes.
3. Solvent.
4. General Utility.
5. Miscellaneous.

USE OF ALCOHOL AS A FUEL

Alcohol is used for the production of heat, light and power. Since the combustion of alcohol is smokeless and odorless, it is an excellent fuel for use in small stoves, chafing dishes, cigar lighters and a variety of similar devices.

When alcohol is gasified and burned beneath the familiar Welsbach mantle, a clear white light is produced. Burned in this manner a given volume of alcohol will produce over three and one-half times as many candlepower-hours as the same volume of kerosene burned in a good kerosene lamp.

The use of alcohol for power purposes has never been extensive in the United States due in part to the cheap petroleum products available and in a great measure to the reluctance of the Government to remove the restric-

tions which interfere with the development of the art of manufacture of alcohol, curtail production, and increase the expense of operations. In Europe, on the other hand, alcohol in admixture with other liquid fuels has been very extensively employed as a motor fuel.

ALCOHOL AS A RAW MATERIAL IN CHEMICAL PROCESSES

Oxidizing Processes. The oxidation of alcohol to acetic acid by air in the presence of an enzyme catalyzer has long been a familiar process. It is only recently, however, that the oxidation of alcohol to aldehyde, and the aldehyde to acetic acid, has been brought about by inorganic catalyzers.

Other commodities which may be mentioned as the products of oxidizing processes are chloral hydrate, chloroform, iodoform and fulminate of mercury.

Dehydrating Processes. The dehydration of alcohol gives rise to ether or to ethylene according to the manner in which it is carried out. The dehydration with sulphuric acid under carefully regulated conditions produces ether. The dehydration of alcohol to ethylene with aluminium oxide as contact catalyst is a recent war development of considerable interest.

Esterification. The production of such esters as ethyl acetate, ethyl formate, and ethyl chloride has been somewhat stimulated by war conditions. Numerous other esters, including ethyl butyrate, oxalate, benzoate, succinate, and aceto-acetate, are also of commercial importance.

Ethylation. Alcohol furnishes the ethyl group for the production of the alkylamines, ethyl and diethyl aniline. It is used also in the ethylation of the phenolic group of para-nitro-phenol in the production of acetphenetidin.

ALCOHOL AS A SOLVENT OR LIQUID MEDIUM

Alcohol, next to water, is undoubtedly the most important solvent. A brief consideration of its multitudinous uses bears out this fact.

Solvent for Gums. Shellac and spirit varnishes are produced by the dissolving of shellac and other gums in alcohol. The alcoholic solution of shellac serves a variety of purposes and is necessary in the manufacture of felt and straw hats, mirrors, brushes, electric lamps, patterns for the foundry, etc.

Solvent for Soaps. On account of the fact that the soaps dissolve in alcohol, this substance is used in the manufacture of transparent soap and certain soluble cutting oils. Alcohol is solidified by means of soap. In this form it is used as a fuel for cooking or heating purposes.

Solvent for Essential Oils. Alcohol is used both in the manufacture of essential oils and in the preparation of essences. A few typical examples are essences of vanilla, lemon, wintergreen, rose, jasmine, heliotrope and bay.

Solvent for Nitrocellulose. While alcohol alone is not a solvent for nitrocellulose, it is used in large quantities mixed with ether in the manufacture of smokeless powders, and collodion. Collodion is consumed in large quantity in the production of artificial leathers, and in smaller quantities in the manufacture of artificial silk. Small amounts of alcohol are used in the preparation of photographic emulsions and in the making of carbon lamp filaments. The manufacture of pyroxylin plastics calls for the use of a considerable quantity of

alcohol. The fact that alcohol in itself is not a good solvent for nitrocellulose is made the basis of the solidification of alcohol by the production of some form of emulsion or colloid of nitrocellulose in alcohol.

Solvent for Dyes. Alcohol is used as a solvent in the manufacture of a great many dyestuffs. It is also useful as a medium for the vending of colors to the trade in the form of solutions or pastes. Alcohol soluble colors are used in the making of confectionery and artificial flowers, and in calico printing.

Solvents for Drugs and Chemicals. Alcohol is necessary as a solvent in the processes of preparing a variety of drugs and chemicals. A few of these substances which may be mentioned are aloin, arbutin, baptisin, cimfunin, coumarin, hydrastis, inisin, mandrake, phenolphthalein, phytolaccin, strychnine, tannic acid and viburnin.

Solvents for Use in the Preparation of Tinctures. The alcoholic solutions of numerous drugs and chemicals are placed on the market as tinctures. A few typical examples are tinctures of aconite, arnica, cantharides, digitalis, iodine, and nux-vomica.

Solvent in Crystallization Processes. A large number of substances are recrystallized from alcohol, among which may be mentioned aconite, beta-naphthol, beta-naphthol benzoate, guaiacol, guaiacol carbonate, monobromated camphor, ortho-toluol sulphamide, phenyl salicylate, and terpin hydrate. In the case of other substances, such as trinitrotoluol (TNT), crystals are sometimes washed with alcohol to remove impurities.

Alcohol as a Cleaner or Cleanser. Oil and shellac are removed from metal parts by means of alcohol in the process of manufacture of various articles such as cutlery, jewelry and watches, silverware, bronze and art metal work, and special glassware such as thermometer and barometer tubes.

Solvent for Oils and Waxes. Alcohol is used in the manufacture of celery oil, shoe polishes, and paint and varnish removers. It is used in the refining of mineral oils for the production of the highly refined medicinal oils. It is sometimes used in the purification of rubber to dissolve foreign gum and waxes.

Alcohol as a Diluent or Thinning Solvent. A number of preparations such as airplane wing dopes, metal lacquers, enamels, polishes, lotions, and linaments contain alcohol as a diluent.

ALCOHOL AS A LIQUID OF GENERAL UTILITY

In the hospital, the chemical laboratory and the home, alcohol is a liquid medium of general utility. In the hospital it serves as an antiseptic and as an ablution. In addition to these purposes, it is used extensively in the home as a fuel and cleaner. Its indispensability in the laboratory is too well known to every chemist to need elaboration.

MISCELLANEOUS USES OF ALCOHOL

Alcohol finds application for a variety of purposes which are difficult to classify. It serves as a preservative for specimens in biological museums. Many proprietary medicines also contain a certain proportion of alcohol added to preserve other components of the mixture.

The addition of alcohol to the water in automobile radiators, hydraulic jacks and presses in the winter

time prevents freezing. This has proved of extreme importance in the war. Water is frequently scarce near the battlefield, and it is highly desirable to be able to avoid the draining of the water from radiators at night. An economy of gasoline also has been effected through lack of the necessity of keeping the engine running when a car was idle for a short time.

Alcohol is used to remove the carbon from automobile engines or other gas or gasoline engine cylinders. The "carbon" is an accumulation of siliceous dust, carbon and heavy tar and oil. The solvent effect of the alcohol on the oils and tars is responsible for the removal of the carbon.

Alcohol is used as an antiseptic. Solutions of such substances as resorcin or beta-naphthol in alcohol are exceedingly valuable in this connection.

Alcohol serves as a reaction medium in the manufacture of a number of substances among which may be mentioned santonine benzoic acid and sodium benzoate.

The small solubility of certain substances in alcohol is responsible for the use of alcohol in their processes of manufacture. Such substances are inulin and glycerophosphates.

CONCLUSION

It has been possible in the foregoing paragraphs only to mention some of the many uses of alcohol in the arts and industries, but this brief enumeration is sufficient to illustrate the ramifications of this substance into manufacture in general. Its importance at present cannot be overestimated. Its future possibilities are limited only by the regulations with which its use is circumscribed.

U. S. Industrial Alcohol Co.,
New York City.

Utilizing Waste Sulphite Liquors

In 1906 letters patent were granted to Jacob S. Robeson for a process to neutralize and concentrate *in vacuo* the waste liquors of sulphite pulp mills. The inventor and his associates made the proposition to a pulp mill that was having trouble with stream pollution, to put the offending waste to use and a little test plant was built with a view to producing by this means an adhesive to make sand cores for hollow castings. How much of the offending liquor could thus be disposed of was a question, and it stands to reason that the amount, during the formative period, was not large. In the meantime the proprietary company has developed so that it now has two large evaporating plants which substantially consume and thus dispose of the waste liquor output of two large sulphite mills, one at Au Sable Forks, N. Y., and the other at Covington, Va.

The feature of general interest which we think worthy of emphasis is that in the instances of these two mills, the waste liquor nuisance is said to be practically eliminated. The process, roughly, consists in neutralizing the liquor and evaporating it to a thick syrup or to dryness under reduced pressure. Of course there are stratagems and refinements in the process. The ligneous spruce product is sold under the trade name of glutrin. It is, in substance, the sulphonated lignins neutralized with lime and magnesia, with other bases substituted or the lime removed for special purposes by processes patented and controlled by the company.

As a core binder it did well from the start and its use in this respect has already reached large proportions. But even if all the foundries in the world should use it, a few pulp mills could supply the entire demand. Later research, however, proved that the gum had an unusual affinity for clay and the manufacturers set out to introduce the product as a road binder.

Portland cement with sharp sand in volume 1 to 3 breaks approximately at 200 to 230 lb. Glutrin with sharp sand mixed with 15 per cent of clay shows the same tensile strength in volume of 1 to 25.

Other uses are coming to the fore, but none with the possibilities of road binding except, perhaps, as an adhesive for briquetting. Much less glutrin is needed than pitch for this purpose and in this respect it is promising, owing to its cheapness as well as its effectiveness. Last winter during the coal famine it was found useful to bind coal dust for boiler purposes without going through the process of briquetting. Coal dust, which was all that was obtainable by some landlords, was dumped upon the boiler room floor, glutrin was poured upon it which immediately bound it, and then it was fed wet into the fire boxes of the boilers. Several large buildings were kept warm by this means which otherwise would have been closed by the cold. When glutrin is submitted to the high temperature of the fire under the boilers it burns completely.

Still another use after it has undergone purification is for finishing leather in the tanning industry. It contains 25 per cent of tanning materials, which is significant. This application is also increasing.

The material itself is soluble in water but it can be made practically waterproof. If two pieces of paper are held together by an exceedingly thin film of glutrin, they become impervious to oil and grease, and it is suggested that cartons made of paper with glutrin sandwiched in between the sheets, would make good containers for oily substances.

Again there are indications of its use in the textile industry, although no method of bleaching has thus far been devised.

More important than the introduction of a new technical material is the avoidance of sulphite pulp waste liquor. We continue to talk a great deal about this nuisance but it continues to flow into our most beautiful streams and to kill fish merely as one of its many vices. Evaporated, it has its uses, but not enough. What interests us especially is that some application be discovered for evaporated sulphite waste liquor, whether prepared by this process or any other, so that one of the greatest of all sources of stream pollution may become a thing of the past. If a large, general use for the product could be discovered we should soon see a treating establishment attached to every pulp mill and a source of serious offense turned into an asset. The chemist who solves this problem will probably reap a fortune, but he will also be justly entitled to a medal from Congress, and the day of its accomplishment may not be so far away, either.

Artificial Honey is reported as being prepared in Germany. The hydroxide or other suitable compound of iron is added to sugar during inversion whereby salts of iron are produced with the acid used for inversion and saccharates of iron with the sugar.

Organic Synthesis and the duPont Company

Evolution and Growth of a Varied Organic Chemical Industry—Introduction of Nitro Explosives Brought About First Advance—American Chemical Manufacturers Must Blaze New Trails and Engage in Thorough Research

BY C. L. REESE AND C. M. STINE

SYNTHETIC organic chemistry has been a factor of such great importance in the development of the wide variety of the du Pont Company's products that it is difficult to pick out of the finished products marketed by this company any one product in the development of which the organic synthetic chemist has not had a part. Evolution and growth are not necessarily simultaneous processes. The former represents increasing complexity and better adaptation to commercial requirements and is more important than mere growth, consisting of expansion without added differentiation. It is safe to say that the development of the du Pont company has been characterized by both. During the very early years of the life of the company, when its activity consisted almost solely in the manufacture of black powder, no applied organic chemistry was involved, but this situation was altered with the introduction of nitroglycerin and nitrocellulose explosives. The next great advance came with the introduction of the benzol high explosives which led quite naturally into the field of coal-tar products, in general comprehending intermediate and dyes as well as numerous other products in adjacent domains of manufacture, all logically associated with each other.

STUDY OF SYNTHETIC GLYCERINE.

Dynamite contains as one of its most essential constituents nitroglycerine or similar nitric ethers, together with one or more organic compounds of a similar nature, added for the sake of introducing some special property or properties in the finished product. The manufacture of nitroglycerine itself has meant for this company not merely the nitration of glycerine but also the study of various methods for synthesizing glycerine. Coincident with the study of synthetic glycerine the study of other nitric ethers of very similar properties has been under way for years and has resulted in the synthesis of certain nitrated products, true nitrates—not nitro substitution products—which have served to replace varying quantities of nitroglycerine and at the same time to give the dynamites certain very valuable properties not conferred upon them by the use of nitroglycerine alone.

Then too there is the field covered by the nitro aromatic compounds which are used not only in admixture with nitroglycerine and other nitrated alcohols of similar constitution, but some of which are themselves employed as explosives. The manufacture of nitro compounds derived from benzene, toluene, xylene, phenol, cresol etc., has often involved not merely the study of the action of nitric acid upon these organic compounds but in some cases has involved a study of methods for the manufacture of the compounds them-

selves. Toluol has been produced on a commercial scale by the du Pont company for some years past, and, of course, synthetic phenol and the synthesis of picric acid through chlorbenzol instead of by the nitration of phenol are operations which at once occur to every chemist who may chance to read this article.

It is scarcely necessary to say that such compounds as tetranitromethylaniline, the "tetryl" of commerce, have been manufactured by the du Pont company for some years and that the manufacture was worked out as a going proposition before the great war had started. The nitration of benzol, with the production of mononitrobenzol and from this of aniline, had led to the manufacture of diphenylamine and dimethylaniline.

EVOLUTION OF NEW EXPLOSIVES

The development of new explosives so necessary to enable the du Pont company to develop its great explosives business has, of course, led to the study of a very wide field of organic compounds which for one reason or another were believed to be worthy of investigation for the sake of determining their possible suitability in this connection. A number of very useful new explosives have been developed and some of these compounds will no doubt prove a fruitful source of interesting investigation when a study is made of their properties other than explosive.

The manufacture of smokeless powder involves a very expert knowledge of the nitration of cellulose and the conduct of various nitrates of cellulose in different solvent media. This business very naturally went hand in hand with the development of such products as lacquers, pyroxylin solutions and leather substitutes. These lines of business, calling for colors, involved either the purchase of dyes, pigments and lakes from outside sources or the manufacture of these products by the company. The company preferred to engage in the manufacture of these products for itself, because of the close relation to its business as a whole as well as because it is one of the largest manufacturers of heavy chemicals in the world.

The preparation of the nitro aromatic compounds already referred to is so closely akin to the preparation of some of the raw materials used in the manufacture of dyes that it was scarcely a step for this company to launch out into a very comprehensive manufacture of intermediates used largely for dyestuffs, as well as in a more limited way for pharmaceuticals. When one enters the wide and fascinating field of the chemistry of dyes and intermediates, the activities of the organic chemist at once become of the first importance. This is so well known that it is scarcely necessary to do more than mention in passing that hundreds of chemists are

engaged in the manufacture of various organic compounds used for explosives and dyes.

DIFFICULTIES OF ORGANIC SYNTHESIS

In a surprisingly large number of cases chemical investigation of synthetic processes has resulted in the discovery of improved methods, differing widely from those previously employed. In all cases the study of synthetic methods has resulted in less radical though no less important changes in the methods themselves. Nothing sounds easier than the preparation of some well known organic compound such as diphenylamine. A cursory examination of the literature furnishes a description of various methods of preparing this material, but like all other organic reactions it requires careful control if satisfactory results are to be obtained. It is influenced by conditions which are nowhere mentioned in the literature because they can be ignored in the small scale preparation of the material. Furthermore, the chemical manufacturer who produces this material in large tonnages is not given to publicity in regard to details which determine the success of his plant. Every stage and every detail of preparation must be subjected to the closest scrutiny. Wholesale production of course requires more accurate regulation than does laboratory preparation. When a pound of the material is prepared the occurrence of small amounts of by-products is ignored, except in so far as these by-products and residues merit study because of the light which such a study may throw upon the reaction. But the large scale manufacture may fail entirely because of the accumulative catalytic effect of small amounts of by-products developed in the reaction and adhering to the interior of the apparatus from one run to the next, even though the bulk of the product is removed from the apparatus after each charge.

VARIED PROBLEMS ATTACKED BY DU PONT CHEMISTS

Perhaps it would be interesting to enumerate a few of the many and varied problems which the organic chemist has turned his attention to at one time or another in the synthetic laboratories of the du Pont company. The company is manufacturing brushes for "my lady's toilet table." The handles and backs of these brushes call, first of all, for cotton of a particular grade and the purification of this cotton. Next, this specially purified cotton, the properties of which have been studied from every standpoint in so far as the nature of the impurities present in the cotton and the methods followed in their removal may affect the desired properties of the finished article, is subjected to the action of a mixture of nitric and sulphuric acid, and the nitric ether of cellulose thus obtained is ready for purification. Here again the most thorough-going and far-reaching study is made of the effect of various impurities in the nitrocellulose and the effect of the different methods used for removing these impurities upon the physical and chemical properties of the finished toilet articles. Perhaps the finished toilet article instead of being white or cream colored is to be tinted or is to be inlaid with some colored design. It is necessary to study the various coloring matters available, with a view to selecting such dyes as may be soluble in the solvents employed in working up the nitrated cellulose, and at the same time dyes which will show

the necessary fastness to light and the necessary stability so far as the action of the colloid or of the air is concerned. Now the brush is complete save for the insertion of the bristles. Here a new problem presents itself—a shortage of the natural bristles which used to be imported before the war. It becomes necessary to attempt to prepare artificial bristles. At first glance this seems a simple proposition, but a naturally produced bristle has many unique properties and it becomes necessary to make a most painstaking investigation of the nature of these properties which give the natural bristle its character in order that in the duplication of this bristle it may be possible to decide when a synthetic article of the proper degree of excellence has been prepared.

PRODUCTION OF ARTIFICIAL LEATHER.

Closely related with the production of articles of "pyralin" is the production of the class of goods known as artificial leather or fabrikoid. The coating of suitable fabrics of various weaves and tints with pyroxylin solutions and the subsequent fabrication of these coated goods to a leather-like finish has involved the attention of many chemists, and many interesting discoveries have been made in this connection. The manufacture of fabrikoid well illustrates the variety of chemical processes and products which may be involved in the fabrication of single class of goods. Suitable purified cotton, acids, alkalies, solvents, oils, dyes in wide variety of shade and chemical properties, pigments, etc., enter into the manufacture of artificial leather.

It is worth pointing out in this connection that the field of the organic chemist is by no means merely the imitation of nature's products, but oftener than not the problem involved is the actual building up in the chemical laboratory of the identical product which nature herself has cunningly synthesized in the organism of the plant or animal, as the case may be.

SYNTHETIC INDIGO ILLUSTRATES PROBLEM OF LARGE-SCALE PRODUCTION

The manufacture of indigo well illustrates the nature of certain problems which arise if the chemical manufacturer attempts to produce on a large scale even such a product as this which has been produced for some years on a large scale abroad. If the chemical turns to the literature he finds many methods for the preparation of this material, but it is a question not merely of the selection of a method which will produce indigo but of the selection of that method which will best produce indigo of the highest quality and in the most economical way, from certain raw materials which are available because of the du Pont company's activities along other lines. Having selected the method which is to be followed, the next question is the design of the most suitable apparatus for carrying out this method on a very large scale. Without going into wearisome detail, it suffices to say that all of these phases of the problem have been studied and successfully solved and an indigo produced which is much purer than that which is obtained by the extraction of this dye-stuff from its naturally occurring sources.

The embarkation of this company upon the great field of related industries comprehended under the caption "duPont American Industries" will no doubt mean

a wonderful stride forward for the American chemical industry. The logical course is to build an industry which is not merely concerned with chemical products in the narrower sense but with all the logically related forms of the industry. As in the past, success in organic synthesis as a commercial asset can only come to mean what it should if it is properly associated with evolution of the whole industrial organism of which it is a part. We are confident that new processes or distinct improvements over foreign methods of manufacture will characterize the activities of this concern. This is logically to be expected because the chemical manufacturers in the United States start with a clean slate, unhampered by tradition, unencumbered by equipment which may have grown more or less obsolete but which it would be too expensive to abandon. It is necessary above all things that the American manufacturer shall not merely attempt to follow the well beaten paths, but that his activities be controlled by a thorough and painstaking application to his manufacturing problems of the results from the laboratory of the thoroughly trained and skillful synthetic organic chemist.

Wilmington, Del.

Prices of Sulphuric and Nitric Acids

The War Industries Board announced on September 26 that, subject to the President's approval, the following maximum prices were agreed upon at a meeting between manufacturers of sulphuric and nitric acids and the price fixing committee. These prices are to remain in effect for the remainder of the year:

		2000 lb.
Sulphuric Acid	60 deg. Bé	\$16
.....	66 deg. Bé	25
Oleum	20 per cent	28

All acids below 66 deg. Bé. are to be evaluated on a \$16 basis and above 66 deg. Bé., on a \$25 basis. One-half of one per cent additional charges are to be made for carload lots of carboys, and three-fourths per cent for less quantities. One-quarter of one per cent will be charged for steel drums.

		2000 lb.
Nitric Acid	42 deg. Bé	\$170.00

One-fourth of one per cent extra charges are made for drums. There shall be no extra fee for mixing charges of mixed nitrating acids, the prices of which are figured on the acid contents.

Two Great Drives, One of Them Here

Two great drives are on to release the world from the hardships of war and preserve mankind from the horrors of autocratic rule. One is along the Western Front in France, Flanders and Lorraine; the other is in the United States.

American soldiers are bearing a brave and splendid part in the military drive "Over There." The American people over here must work as well for the success of the Fourth Liberty Loan drive.

Upon the success of the loan depends the maintenance of the striking force of our troops.

It may be hard for many of us to spare money at this time, even though it is to be returned to us with interest; but it would be still harder for us to think of having failed to do our part if the loan should fail.

Manufacture of Glycols

BY HAROLD HIBBERT

Director Research and Technical Division,
Ralph L. Fuller & Co., Inc

IN a preceding article on "Industrial Developments Relating to the Manufacture of Acetic Acid and Acetone," attention was drawn to the scarcity of acetone occasioned by the increased production of cordite, and of the steps taken to meet this deficiency. Regarding the other two constituents of this explosive, namely nitrocellulose and nitroglycerine, thanks to our abundant natural resources little or no difficulty was experienced in increasing the production of nitrocellulose, but the amount of cordite capable of being produced at the present time is limited by the amount of nitroglycerine available.

As is well known, nitroglycerine is obtained by treating glycerine with a mixture of nitric and sulphuric acids. The glycerine itself is obtained by heating vegetable oils, such as palm oil, cottonseed oil, etc., on the one hand, or animal fats on the other, with caustic alkalis or other saponifying agents producing in this way glycerine and soap. Animal fats form an indispensable, staple article of diet and the same remark now applies to vegetable oils, since from these, by the so-called process of hydrogenation (consisting in treating them with hydrogen), these bodies are converted into butter substitutes and so serve to replace animal butter and animal fats.

It thus becomes an economic problem as to how far the manufacture of glycerine may be permitted without interfering with the use of raw materials for domestic consumption. An idea of the amount of glycerine used in this country prior to the war, may be obtained when it is stated that some 20,000 tons of this material was employed annually in the manufacture of nitroglycerine, while another 7000 tons was used in the manufacture of tobacco. The other uses to which glycerine was put amounted to probably around 3000 tons, so that the total annual consumption in this country prior to the war did not fall far short of sixty million pounds.

Numerous attempts to prepare glycerine synthetically from other cheap available raw materials such as sugar, petroleum, etc., have been made, but so far without success. It is a well known fact that in the fermentation of wine, a considerable amount of glycerine is formed from the sugars present, but all attempts to identify the organism and to imitate the process commercially, have so far proved failures. As far as can be judged, there would seem to be comparatively little outlook at present for a successful commercial synthesis of glycerine from known available materials. At the same time, it is not possible to increase the supply of glycerine without in turn diminishing the supply of foodstuffs.

During the last six or seven years the writer has devoted a considerable amount of time to experimenting on this subject, and now believes that in a certain class of products known as glycols, which are closely related on the one hand to ordinary alcohol, and on the other to glycerine, a solution of this problem has been found.

If alcohol is passed over certain contact materials, such for instance as oxide of aluminium, at an elevated temperature, it undergoes a chemical decomposition with the formation of steam and a combustible gas known

of the nitroglycol displacing in future the less satisfactory nitroglycerine explosives.

Furthermore, as regards its use as a constituent of cordite, it is necessary, as stated in the writer's previous communication, in order to bring about an intimate compounding of it with the nitrocellulose, to employ a solvent, which in this case is acetone. This necessitates considerable care and expense in manufacturing, as the value of the explosive is naturally dependent on the absence in the finished product of all traces of the solvent.

We are informed by Mr. Arthur Hough, formerly of the Canadian Explosives, Limited, that extensive experiments carried out by him with nitroglycols on the semi-industrial and industrial scale show that when compounded with nitrocellulose (no solvent being necessary), a valuable new type of explosive is obtained, possessing characteristic properties which indicate that it should be capable of finding a wide outlet both as a war material and for peaceful purposes. With regard to cordite, it is a well known fact that due to the high local temperature produced in the ignition of the charge in big naval or coast defense guns, considerable erosion is produced in the barrel, so that the life of such a gun is limited. This erosive action, will, it is considered be found to be much less pronounced with explosives derived from nitroglycols than from nitroglycerine.

Another new type of explosive, in addition to those described above, has been discovered by the writer. It has been found that sugar is readily dissolved on warming with the glycol and that if such a solution is then treated with a mixture of nitric and sulphuric acids, not only is the glycol itself converted into an explosive body, but the sugar also yields a nitrated product and the combination of the two thus formed is found to possess many valuable properties not associated with any present known types of explosive. There would seem to be solid ground for the belief that such a product should find an extensive application in various branches of the industry, such as mining, blasting, excavating, etc. In view of the fact that one of the principal constituents, namely, sugar is a material available in practically unlimited quantity and at a low cost, it is anticipated that the cost of production of these new products will be materially lower than that of similar bodies derived from nitroglycerine, thus insuring them a very wide outlet.

The glycols themselves have been found to possess many other valuable properties, serving to indicate that they should find a wide application in the field of industry and commerce, so it may be anticipated that in the future the use of glycols will largely displace that of glycerine.

Thus for instance, with regard to the use of glycerine for moistening tobacco, it is known that the combustion of glycerine gives rise to the formation of a poisonous product known chemically as acrolein, and it is assumed that it is the inhalation of this product during smoking that produces in the case of persons susceptible toward such bodies, various types of disorder in the mouth and throat. The chemical composition of the glycols is such that it is impossible for acrolein to be produced when employed for such purposes.

The glycols possess, if anything, a superior attractive power toward water, so that their moisture-retain-

ing properties are even more pronounced than in the case of glycerine.

It is this so-called hygroscopic property (that is, the ability to absorb and retain water) that would seem to make glycols such valuable products for use in the pharmaceutical and allied industries, as for instance in the manufacture of salves, ointments, dressings, etc.

It is also confidently anticipated that the glycols will, on account of their much lower volatility and their affinity for water, prove capable of being used with success to replace alcohol in automobile radiators in order to prevent the water from freezing.

The manufacture of glycols and their industrial applications is a subject which, as stated above, has occupied the writer's attention for a considerable number of years, and due to the fortunate patent protection already available, it is confidently anticipated that rapid strides will now be made in the development of this industry.

The Government has undertaken to investigate the properties of these materials for war purposes, having had the free use of the patents in connection with the same placed at its disposal by the writer for the duration of the war.

There are already in existence certain large factories which are capable of providing raw materials for these products on an immense scale after the conclusion of peace and there is no doubt that with the development of this field a big advance in the true conservation of foodstuffs will have been attained.

New York City.

Bauxite Deposits in Guiana

Sir Walter Egerton, in his address before the Royal Society of Arts, stated that in 1897 and again in 1910 Professor Harrison reported that extensive deposits of high grade bauxite were located in British Guiana. This discovery was not fully appreciated until five years ago, when the Northern Aluminium Company of America applied for leases of areas containing such deposits. The British Government stipulated that any company working this bauxite must be under its control. After long negotiation, an American company was formed to meet these requirements, and the first cargoes of bauxite were but recently mined and shipped from the colony.

This company has acquired large areas of land from private owners and leases of considerable extent of crown land in the vicinity of Wismar, at the head of navigation of the Demerara River, near the terminus of the little railway connecting the Demerara and Essequibo rivers. Ships with less than 16-foot draft can reach the mines 60 miles above Georgetown.

The bauxite deposits have recently been traced almost from the Venezuelan boundary across the colony to the border of Dutch Guiana. Further deposits have been located in Dutch and French Guiana and it is now thought that this northern strip of South America contains the most extensive deposits of aluminium ore in the world accessible to ocean transportation. The geological formation of bauxite is similar to our secondary fall-line clays, being deposited at the pre-coastal line.

In the United States pockets of bauxite are being worked in Alabama, Georgia and Arkansas, but the shallow depth of the usual bauxite formations makes the Guiana deposits extremely important.

Micro-Organisms in Plant Chemistry and Nitrogen Fixation

An Account of the Development and Application of Micro-Organisms Useful to Plant Growth—
Fixation of Nitrogen in the Soil

BY ELLWOOD HENDRICK

A FEW miles to the west of Hackettstown, N. J., there are some three or four thousand acres of meadow-peat or muck which was formerly covered by a swamp. Underlying it is usually a thin layer of sand which in turn rests upon blue clay. The depth of the greatest part of the muck is from four to six feet, although in places it is but 18 inches; occasionally, it goes down as far as twelve or fifteen feet. Where it extends below the water table there is usually found a layer of fibrous peat above the sand, but there is not much fibrous peat in this district, which is known as Great Meadows or Bog Egypt.

The muck is, in effect, humus, and its use is for fertilizer. But before we begin to consider the technical generalities which follow, let us bear in mind that humus is partly decayed organic matter; that it is the decayed remains of former generations of plant and animal life, on its way to become coal, and beyond the peat stage. Its value is influenced by the kind of organic matter from which it originates, and the state of its decay. Much of its value is due to its nitrogen content, and in this respect, if its origin were cellulose, it would be nil; if it were clover it would be considerable and if derived from the decayed carcasses of animals, it would be higher still. Indeed, the index of its nitrogen value is its pre-geologic history.

But apart from this, humus has other qualities which cause it to function in the support of plant life. It acts as a flocculent in clay and as a binder in sand which might offer at the start a pretty thesis in colloid chemistry. It retains moisture like a sponge, which is another good subject for original work. It supplies, according to its content, nitrogen, phosphorus, potash, lime, iron, manganese etc. for the nourishment of plants, and it is the natural habitat and food of beneficial soil micro-organisms.

NEUTRALIZING VALUE OF LIME

The New Jersey deposit has the advantage of constituting the drainage area of the surrounding limestone hills whereby enough carbonate of lime is brought down almost to neutralize the humic acids. Still another advantage is that 30 years ago the swamp was completely drained and then practically abandoned. There was lacking the proper understanding of the value of the humus and the development of engineering as well as chemical and biological methods of treatment which later study has supplied. The great value of this preliminary draining in increasing the bacterial life will shortly appear.

For the past twelve years Mr. John N. Hoff of New York and his associates have been engaged in the development of the industry in New Jersey, and later they

have extended their activities to certain other rich deposits in Florida. While the undertaking is to be classed as a fertilizer proposition, it differs materially from fertilizer manufacture and materials as generally understood in chemical engineering.

We often hear fertilizer discussed as though it had to do with abstract problems in chemistry. We know of no other subject to which the popular mind has attributed more than its rightful share of this science. We do not mean to say that the chemistry of fertilizers has been adequately studied; on the contrary, it seems as though, to mention but one of many features, that the great field of protective colloids in the soil holds all sorts of treasures that have not yet been uncovered.



THE DIGGER AT WORK

What has often been forgotten is that agriculture is a profession within the domain of plant physiology rather than of chemistry. In what follows we shall observe that a balanced conception of fertilizers has ruled and that its biological aspect has received its proportionate attention.

MICRO-ORGANISMS REQUIRE FREE OXYGEN

Operations are carried on under a corporation known as the Alphano Humus Co. and research is prosecuted in various directions under the auspices of that company. We are informed that there are promising indications that it may become possible by simple treatment to bring the humus into a condition whereby the solubility of its nitrogenous bodies may be under almost complete control. The value of such an achievement needs no comment.

The micro-organisms which are most useful to plant life in the soil are of an aerobic nature; that is, they require free oxygen for their development and growth. They do not thrive under water. Therefore the first step in the development of such bogs is to drain. Here we

may note the value of the operations at Great Meadows thirty years ago, because the zymotic growth begins immediately after the water has been removed. Here also we may note again the value of the surrounding hills, for whenever humus is found to be acid it must be limed. As the bacterial life proceeds, some of the carbon in the organic matter goes off as CO_2 , while under the action of the nitrogen fixers the nitrogen con-



TRANSPORTING HUMUS FROM FIELD TO WORKS

tent is increased. It is interesting to note that there are nitrifying organisms (actinomyces) which are closely allied to yeast plants as well as moulds or fungi which seem to be especially active, besides the bacteria proper.

The next step is to grow crops under which the condition of the humus improves through aëration, while the crops themselves are record breakers. Onions may be raised to the extent of 1000 bushels to the acre, while 800 bushels may be obtained with ease. Cabbage grows with great vigor and heads up as solid as a German professor when he discusses the cause of the war. Potatoes produce 400 to 500 bushels to the acre while lettuce runs over 1000 boxes to the same area. A box contains 24 large, solid heads. Celery is equally prolific; there are usually over 200 crates to the acre and it takes 120 such crates to fill an ordinary freight car. If all of this district were under diligent cultivation it would effect a material contribution to the metropolitan food supply. Cultivation also eliminates the seeds of weeds.

MINING THE HUMUS

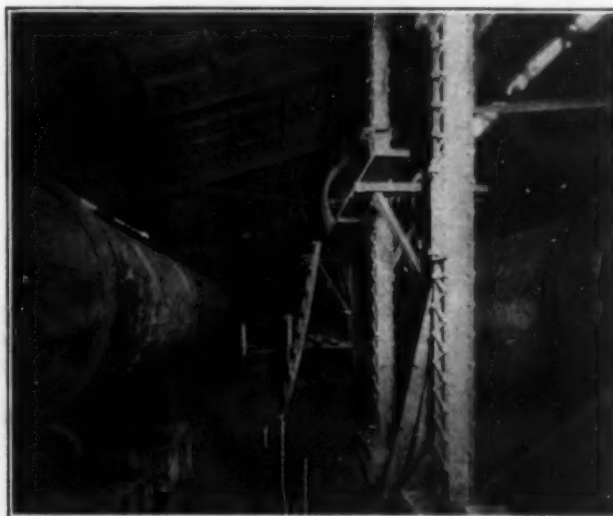
When it is determined to mine the humus after cropping, a temporary narrow gage railroad track is laid upon the surface. Then parallel with the track, at a distance of about 150 feet from it, operations are begun with a specially constructed digger, driven by electricity, with a trailing wire. This proceeds very slowly, digging a trench to any depth up to six feet by means of buckets, scattering the humus upon the surface between the trench and the railroad. Surface water is removed from the trenches by rotary pumps. The surface is then harrowed several times each with tractor-drawn harrows of three types, viz., disc, acme (or corkscrew) and spike-tooth, to a depth of two to three inches. After drying in the sun for a day or more it is pushed to a

depth of about two inches over to the railroad track by means of an electrically-driven scraper. We then have a windrow or ridge of sun-dried humus ready for loading. The water content has been reduced from around 80 per cent to between 50 and 60 per cent. A third electrically-driven apparatus loads it upon dump cars on the track. The digger, scraper and loader are all specially designed and built for the purpose and they do their work exceedingly well. The railway carries it to the factory where the humus is piled in great heaps of 25,000 to 50,000 tons. These are, in effect, composting heaps, and the longer they remain the richer the zymotic life of the humus grows. The moisture content does not increase.

MECHANICAL PREPARATION BY DRYING AND SCREENING

Three separate products are made from this material. The simplest and cheapest is called "humus tankage." To make it, the humus is run through a rotary, direct-heat dryer, revolving six times a minute. It requires about fifteen minutes for the humus to run through. A very simple test provides against over-heating: as soon as it burns, the smell of ammonia is noticeable and the fires are slowed down. From the dryer the humus is passed through screens and the tailings are ground and then also screened, so that the finished product is in a pulverulent condition. The process is carried on under laboratory control. The humus now contains 10 per cent water, 3.25 to 3.50 per cent NH_3 , 0.3 per cent K_2O , 0.4 per cent P_2O_5 and about 8 per cent lime, with 80 per cent and over of organic matter. The bacterial count is light, owing to the high temperature drying.

This is, itself, a low-grade nitrogen fertilizer, but its particular use is as a fertilizer ingredient. In this



ROTARY DRYERS

connection it is better than dried blood because it absorbs water more readily and keeps the mineral content in a more pulverized condition. The advantage of having some of the nitrogen in a mixed fertilizer in organic form is well known. If its fixed nitrogen is made up of ammonium sulphate, ammonium nitrate and nitrogen organic matter, the solubility is more gradual and the loss through seepage is less than if all the nitrogenous is in an inorganic form. If used separately, the effective fertilizer value of nitrogen humus is claimed to be about three times that of NaNO_3 .

The second product is called "prepared humus" and is made from the same basic material, but run through the dryers with a lighter fire so that the water content is brought down to 18 to 25 per cent. This is as low as it can be economically obtained without destroying



HEAPS OF HUMUS AT LEFT AND STABLE MANURE AT RIGHT HAVING THE SAME FERTILIZER VALUE

the micro-organisms. Balancing minerals are added to this, chiefly of a potassic and phosphatic nature, as well as pure cultures of nitrifying organisms, so that the finished, mixed product contains about 3 per cent of NH_3 , 0.5 to 1.25 per cent of P_2O_5 , and one-half to one per cent of K_2O . The organic matter is 75 to 80 per cent. The bacterial count is from 50,000,000 to 300,000,000 per gram, which increases with time. A bacterial count of 18,000,000 per gram in soil is remarkably high. This is a balanced fertilizer of unusual bacterial activity. It is employed by market gardeners and landscape architects rather than by farmers. The manufacturers claim for it a fertilizer value of several times its weight in stable manure and that one ton represents



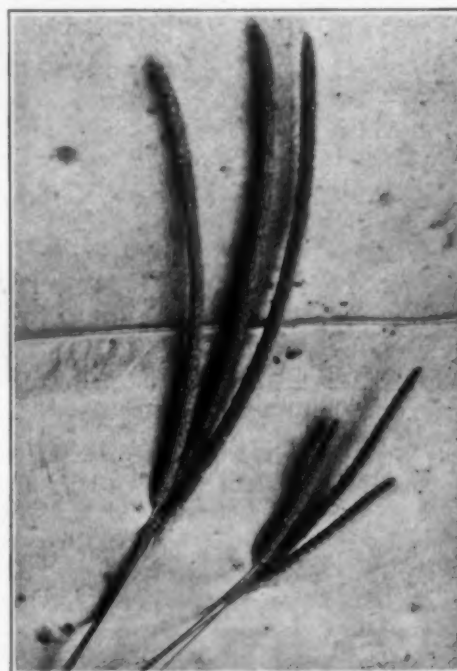
ONIONS AS THEY GROW AT GREAT MEADOWS

the value of many acres of clover turned under and decayed to restore worn-out soil.

ORGANIC FIXATION OF FREE NITROGEN

The third product is called "inoculant" and is prepared by adding first to sun-dried humus various chemicals which render it more available for the growth of bacteria, much as bakers use yeast food in their dough. The inoculant contains ammonifying organisms which decompose the humus and render it more soluble, azotobacter, which live in all soils on the organic matter found in them, and radicolica, which cause the nodules to grow on the roots of leguminosae. Without radicolica

leguminous plants do not form nodules and without nodules they extract only fixed nitrogen from the soil and do not fix free nitrogen. In the described form the inoculant is composted for one year during which time the micro-organisms increase. Then there are added pure cultures of some 28 leguminous bacteria. Of these there are seven main types, of which some will answer for several species while others will answer for only one. Thus that which will inoculate alfalfa will also inoculate sweet clover, and the vetch bacteria will also inoculate garden peas. On the other hand, that which is good for soy beans is not active with anything else, and the same may be said of the bacteria for cow peas.



TIMOTHY WITH AND WITHOUT ENCOURAGEMENT FROM PREPARED HUMUS

To make sure to cover the largest variety of leguminosae, all 28 are put in. Finally there are added five different strains of azotobacter that are valuable in any soil that contains a good supply of organic matter. All of these micro-organisms live, so to speak, on good terms with each other; indeed, each appears to thrive better in the presence of the others.

Here we lose interest in standardized chemical analyses of the product. Two pounds of it are enough to inoculate an acre of land. It is in growing use by farmers, for leguminous crops. A favorite method is to mix one-half of the inoculant needed thoroughly with the seed, before sowing, and to scatter the remainder mixed with dry earth over the soil. Another method is to use it in composting manure heaps. One pound of inoculant, if six months time is allowed for composting, is enough to inoculate one ton of stable manure. The desired organisms do not generate spontaneously in manure; and the lack of them is often the cause of a farmer's bad luck despite heavy fertilizing. The proper use of inoculant seems to point the way toward biological as well as chemical control of fertilizer, which has long been greatly desired. It will be a great day for agriculture when every farmer works with a microscope.

War Problems of the Rubber Industry

How United States Manufacturers Met the Rubber Shortage and Devised Substitutes for Colors and Fillers—Real Triumphs in Making Gas Masks and Balloons—Making of Pleasure Vehicle Tires May be Discontinued

BY ANDREW H. KING

IN COMMON with all other industries, rubber has been called upon to bear additional burdens and to accept new responsibilities because of the war. Undoubtedly the most serious question which is confronting American manufacturers today is the shortage of rubber. When the embargo was first applied by the War Trade Board, factories were allowed seven-sixteenths of their last year's consumption. Ocean tonnage is now in even greater demand than it was a few months ago. As a consequence the ration has been cut to six-sixteenths, or three-eighths of last year's consumption. To meet this situation the manufacturers have agreed to restrict the production of pneumatic tires, tubes, tires for horse-drawn vehicles and non-essentials such as bathing caps, rubber bands, toy balloons, advertising specialties etc. The curtailment is now proposed only for the months of August and September, but it is not unlikely that even more stringent restrictions will be applied and that in the near future the manufacture of tires for pleasure vehicles will be entirely discontinued for the period of the war. The rubber industry is getting over to a war basis. The manufacture of everything that will help win is going steadily forward. Non-essentials are even now in growing disrepute.

Apparently the government has placed every privately owned car, whether Packard or Ford, in the non-essential class. In many instances this is wrong, since the machines furnish transportation to many suburbanites who are thus enabled to live in the country and work in the cities. The curtailment of tires will, no doubt, effect quite a saving in gasoline, but it seems that this desideratum might have been effected easier by licensing owners of cars and restricting their machines to purely business or war-industry purposes.

IMPORTANCE OF TRUCK SERVICE

Truck tires are now in great demand. The value of motor-truck service can hardly be estimated, but it is enough to say that 400,000 new trucks will be placed in operation this year. In every war, transportation has always been the knotty problem. If we had had to depend on the railroads we would not have a single soldier in France today. Between all important cities trains of motor trucks now go back and forth. The railroads put the canals out of business because of superior speed. Truck trains now carry material from Detroit to New York much quicker than the express companies. Whenever anything must be had in a hurry they send a truck after it. Today the trucks are the red blood corpuscles of our defense. Every new machine must have at least four new tires, so on the basis of the above estimate 1,600,000 solid

tires must be provided this year. This figure is low, because many machines are equipped with duals on the rear wheels, making six tires to a truck. These truck tires take a lot of rubber. Of course compounds vary but a 34 x 6-in. solid tire will contain from 20 to 30 pounds of good rubber. It is readily apparent that the increase in solid tire production will more than offset the pneumatic tire curtailment, and it is not improbable that in another year the consumption of crude rubber will exceed the 160,000 tons used in 1917. Many of the new trucks will be owned by the Government but business men are buying them in large numbers. The problem the rubber men must solve is where to get rubber enough to keep the trucks moving. Without tires transportation would be in a hopeless muddle.

There is now no such shortage of raw materials as was in evidence at the beginning of the world war in 1914. Practically all compounding ingredients are produced in large quantities in this country. One of the first to show the effects of war demands was zinc oxide. In 1915-16 it advanced to about double its old price. About this time gas black was introduced. By 1916 there were at least six standard grades of black tires offered. Since then gas black has been recognized as an excellent substitute for zinc oxide and the resulting tire is admitted to be superior in many ways to the old. It has been estimated that fully 30,000,000 pounds of gas black will be used by the rubber industry this year.

SUBSTITUTES FOR COMPOUNDING INGREDIENTS

Another ingredient which caused us no little worry in 1915 was antimony sulphide, which was formerly imported extensively from England and used in rather large quantities in the manufacture of inner tubes. The grades chiefly employed were known as golden and crimson antimonies. They consisted of mixtures of antimony tri- and penta-sulphides in varying proportions, and carried an added free sulphur content approximating 15 per cent. Certain varieties also carried calcium sulphate which was thought to intensify the color. With the beginning of the war, England found need for all the antimony she could produce, so our tube manufacturers had to do without. Many of them developed tubes equally as good as their old products without the least trace of antimony in them. Because of the high regard in which the public held red inner tubes, certain manufacturers colored their products with iron oxide but the larger number sold their tubes on their own merits. By the close of 1915 American-made antimonies began to come on the market and now the old-fashioned tube maker can make just as good a tube as he ever did, but with American antimony,

However, certain other manufacturers liked their new tubes so well that they have not changed them back to the old formulas. The reason for this is not due to any lack of quality in American antimony, but because of some very desirable properties of the new tubes.

Pigments at first gave us considerable trouble. The colors used by the rubber manufacturers are very simple, notably white, black, red, yellow, green, blue, and orange. The white is secured by zinc oxide, lithophone, whiting etc. Because of the extensive use of lithophone in both paints and this industry, a number of new plants for its manufacture have been erected. At the present writing the home demand has been satisfied. Black is the easiest color obtained; the various grades of lamp and gas black are all made at home. The chief red pigment is red iron oxide. It is extensively employed in coloring all sorts of articles. In the old days vermilion, mercury sulphide, was thought to be much better, but it is now recognized as being too expensive and much too heavy. Very pretty shades were obtained by its use, but because of its high specific gravity and the excellence of iron oxide colors it will never be extensively employed again. The yellows and oranges are produced by the different chrome pigments and ochres. At one time considerable arsenic yellow (sulphide) was employed. All these were obtainable in this country. The greens used are the well-known chrome products. There was at first some difficulty in obtaining ultramarine blue but American manufacturers are now producing a satisfactory color. Pigments for the rubber industry must be quite stable and must bear heating with sulphur without any darkening in color or decomposition.

DOMESTIC FILLERS AND ACCELERATORS

Barytes is one of the commonest fillers. It is extensively employed in mechanical goods and in certain high-class compounds, notably frictions. With the beginning of the war we found ourselves cut off from foreign sources of supply. Later the Southern deposits were opened and now there are three grades of domestic products obtainable: (1) An off-color barytes carrying iron which has been finely ground. It is applicable in dark colored products. (2) A white product (ground) from which the iron has been removed by acids. (3) A very fine white precipitated barytes which is much better than the ground product.

Both precipitated barium sulphate and carbonate have been proposed as zinc oxide substitutes. While not as satisfactory as zinc oxide their use in limited amounts is becoming quite general.

The great development in organic accelerators has come about since 1914, so the German dye industries got no chance to control it. At first each company made its own accelerators but now the American dye factories are producing thiocarbanilide, para-phenylenediamine, hexamethylene-tetramine etc. which are quite satisfactory.

There have been some rumors of a shortage in sulphur, but it is believed that with a little conservation our Louisiana supply will be found quite ample. Should the rubber industry ever be put to it for sulphur we may expect some stormy days ahead.

Instances could be multiplied without number where American ingenuity has found the loophole from a try-

ing situation by either finding a way to do without a certain material or by producing it at home. The real triumphs of our rubber manufacturers are not that they kept running full blast in the face of unusual conditions but that when called upon for war products they responded so well. I refer particularly to gas masks. They were expected to furnish all kinds of tires, tubes, and mechanicals as a matter of course, but the gas mask was something entirely new. The gases met with are exceedingly reactive. That rubber was compounded to resist them was indeed a victory. True, the British and French were pioneers, but the American masks are very good if not better than the best our Allies have so far produced. Without gas masks for our soldiers, the Huns would have won this war long ago.

The manufacture of kite and dirigible balloons is another instance. Hydrogen diffuses very readily through ordinary proofed fabrics. It has been necessary to develop new combinations which give maximum resistance. In this field the English and Scottish firms long held full sway. Thanks to their help, American blimps are now equal to those of our Allies.

The rubber industry is mobilized. Everything possible to aid in winning the war will be carried forward. Drags and unnecessaries may expect to be ditched.

Soap Substitutes in Germany

In view of the shortage of fats, attention in Germany is being directed to the use of the natural soap substitutes occurring in certain plants. Thus, the soapwort (*Saponaria officinalis*) contains large quantities of saponin, a fact which can easily be demonstrated by rubbing the leaves or stem in water when a thick soap lather is readily produced. The root is the part of the plant richest in saponin. After digging up, it is thoroughly washed, dried and reduced to as fine a powder as possible. It can then be used, both alone for the hands, and in conjunction with soda for linen. The substance is an excellent detergent with good lathering properties.

A number of other plants can be used for the same purpose, although their saponin content is lower than that of the soapwort. All these are common plants, easily gathered, and in many cases can entirely supplant the costly substance, soap.—(*Seifenfabrikant.*)

Utilization of Reclaimed Rubber in Germany

At the twenty-fourth general meeting of the German Bunsen Society (for applied physical chemistry) held in Berlin on April 8 to 10, 1918, Prof. M. Le Blanc of Leipzig exhibited specimens of a reclaimed rubber named "Agatit," the process of manufacture of which was worked out by him in collaboration with Dr. Lüttke. The material is being made in large quantities both in the solid form and as a fine emulsion. Its use is specified by the Reichsmarineamt in place of natural rubber for the preparation of sheeting and high-pressure packing material such as is used in submarine construction. It is also used as a substitute for leather; it can be nailed or sewn, it withstands sterilisation well, and the difficulty of rapid ageing has been overcome. Such articles as operating gloves (2mk. 50), finger stalls, and teats (0.25 mk.) are on the market.—(*Chem.-Zeit.*)

Carbonization of Coal

Rapid Advances Being Made in Coal Distillation Field—Semi-Coke and Carbocoal With Accompanying High Yields of Tars Rich in Oils

By WALLACE SAVAGE

THE phenomenon of coal carbonization involves highly complex chemical reactions in three phases—the solid fixed carbon, or coke; liquid products, water and tar; and gas. The yield and character of these products vary widely with the nature of the coal and the physical conditions of temperature, pressure, time and contact surfaces. In commercial practice, it is known that practically none of the final products are liberated as such from the coal. Secondary reactions among the primary products have been studied and are

tially unaltered; at 450 deg. F. decomposition into paraffin oils, gases and solid substances begins, the mass fuses, swells and loses weight, and if distillation is completed, a porous coal is left; at 750 deg. F. new gases and vapors are liberated accompanied by a marked increase in the volume of the mass and the development of a very porous cellular structure; at from 825 to 980 deg. F. the liberation of oils is more rapid and in one hour a 36 per cent volatile coal is reduced fifty per cent in volatility and the apparent specific gravity of the residue to

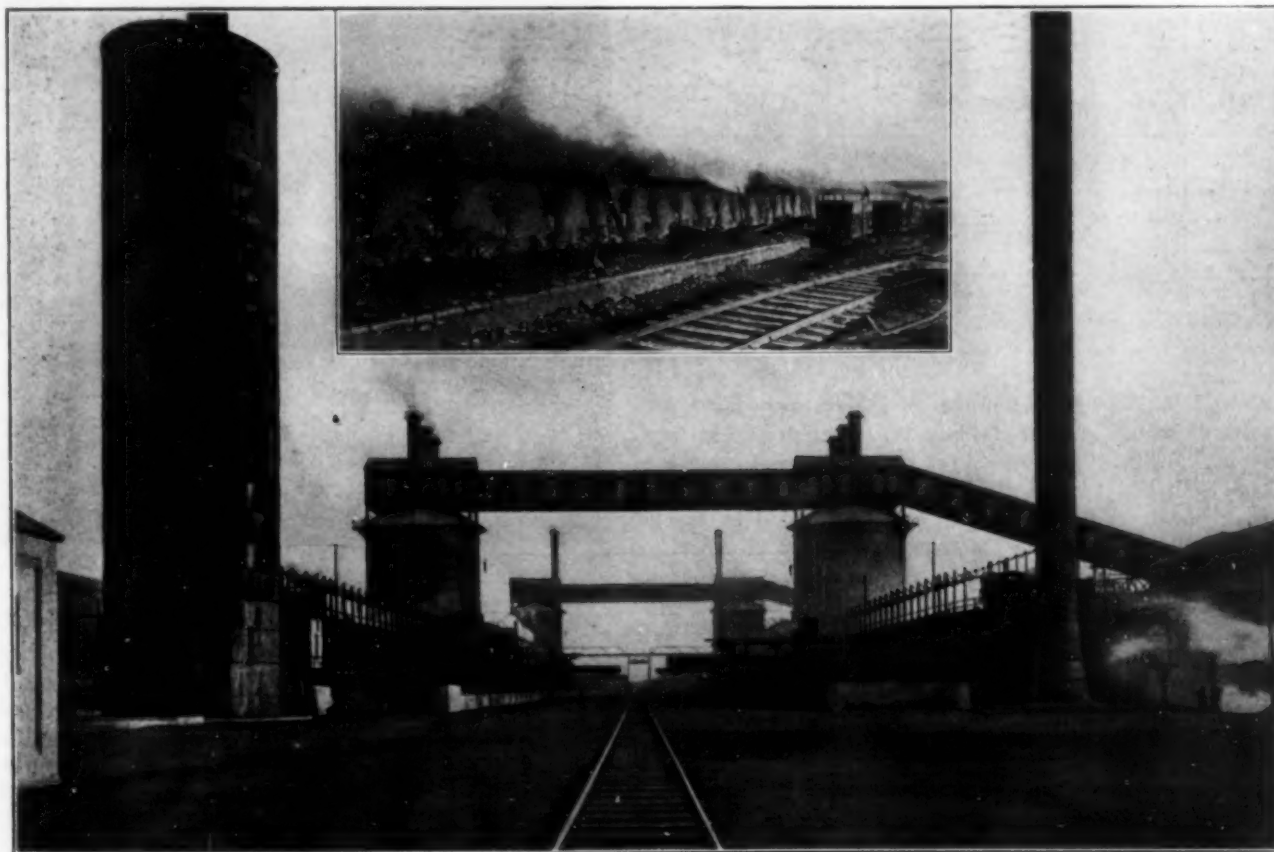


FIG. 1.—THE BY-PRODUCT COKE OVENS AT GARY, INDIANA; BEE HIVES AT BLOSSBERG, NEW MEXICO

known to follow well-known physical-chemical laws. However, the application of chemical statics and dynamics to coal carbonization does not offer a means of simplifying results because of the number of the components in such a system, the only certain factor known being the maximum heat—no average temperature or pressures being determinable. The process may be divided into stages: From 215 to 225 deg. F. the moisture is removed; from 300 to 400 deg. F., a slight superficial softening of the coal takes place and some gases are given off, but the character of the fuel is substan-

about 0.75; at very high temperatures—1500 to 3000 deg. F.—the volatile hydrocarbons are practically entirely removed and the carbon residue fused to great hardness.

In the manufacture of metallurgical coke, the beehive oven has yielded a satisfactory product from coals as high as 32 per cent in volatile matter, while with by-product ovens, the best results are obtained by utilizing harder coals of from 23 to 28 per cent volatile matter. Coals having above 4 per cent moisture content produce inferior results. During the past twelve years, the in-

stallation of by-product ovens in the United States has been phenomenal, practically doubling every four years. In Fig. 1, the story is told comparatively, the familiar bee-hive is hidden in a swarm of black tar condensates and smoke, while the Gary by-product coke plant is a strick observer of the anti-smoke laws. Now that our by-product coke production has about caught up with that of the bee-hive and we are soon to have about five million gallons of coke oven tar per week, a new source with a new type of tar looms into sight, that may revolutionize both our fuel and our coal oil industries.

LOW TEMPERATURE DISTILLATION SEMI-COKE

In 1890, Parker devised a process (Eng. Pat. No. 67) for producing a smokeless fuel by passing steam, water gas, or coal gas superheated to a temperature of 1100 to 1200 deg. F. through a mass of fused coal. The idea of using an inert gas as a heating medium did not give results and after years of investigation, Parker took out his famous Coalite Patent (Eng. Pat. 14,365, 1906) on externally heating coal in the presence of steam to



FIG. 2. BRIQUETTED SEMI-COKE AND FINISHED CARBOCOAL

around 800 deg. F. A number of retorts were tried, details of which are recorded in the English patent files from 1906 to 1911. The first proposal was to use the gas D-shaped retorts about 5 ft. wide, 7 ft. long and 16 in. high, the layer of coal being spread 6 in. thick. Coals with low melting points were distilled in tapering cylinders of about 11 to 12 in. in diameter, a gas outlet being connected with the usual tar recovery appliances. Since these proved unsuccessful, vertical retorts of flat oblong cross-section were tried, with no more success. Next a boiler tube system was installed, batteries of 4- to 6-in. pipes in a fire box being connected with the hydraulic main. These continued alterations in designs furnish an interesting commentary upon the persistence of the Coalite Company in trying to overcome their heating difficulties. The Coalite failures have not led to discouragement, for the work has been carried on in America and the goal apparently reached by the International Coal Products Company.

CARBONIZED SEMI-COKE BRIQUETS

In 1915, Charles Howard Smith¹ undertook to manufacture coke by an entirely new process. He proposed to get an intermediate soft 16 to 20 per cent volatile semi-coke, briquet it with hard pitch under high pressure, and carbonize at suitable temperatures. Fig. 2 shows the green and carbonized briquet product now being marketed under the name of "Carbocoal." This

¹U. S. Pat. 1,177,727 and 1,224,424.

fuel has been tested by several railroads and the U. S. Navy. It burns more freely than coke. With a rate of combustion of 27 lb. per sq.ft. of grate per hour, it evaporated 12.8 lb. of water per lb. of fuel; and with a 100-lb. combustion rate, 8.5 lb. of water. A maximum combustion rate of 166 lb. per sq.ft. of grate surface per hour has been reached. The air space is absolutely constant with this type of fuel. By adding certain minerals to the raw briquets, the melting point of the ash can be raised, so that the fusion of the ash to clinkers is prevented. There is no waste such as breeze etc., as all the accumulated fines are incorporated into the briquets. However, as previously indicated, the



FIG. 3. SEMI-COKE BRIQUETS

Falling from the Machine to a Belt Conveyor, Leading to the Carbocoal Retorts

Smith process is not confined to fuel manufacture, its main feature being in the production of 30 gal. of water-free tar per ton of 35 per cent volatile coal—an increase of from three to four times over ordinary tar yields.

SMITH PROCESS

In the Smith process, any grade of bituminous coal is reduced to about twelve mesh and fed continuously by a conveyor through a compound cylindrical retort having a double system of propelling paddle agitators mounted on two shafts. The retort is built of a refractory material of the carborundum type. The speed of the agitator is about four revolutions per hour, the design being such that the material is subjected to distillation for about one hour. The walls of the retort are heated to about 900 deg. F. externally by the combustion of the gas evolved in the process, checkerwork preheaters being installed below the fire box to make this possible. The retort discharges into an attached

iron hopper, where the semi-coke cools off and is discharged at intervals on to a conveyor which carries it to

to the present time, only 4 or 5 per cent is left, this product burning freely in an open fireplace.



FIG. 4. INCLINED RETORT DURING CONSTRUCTION

a large crusher and Williams hammer mill where it is pulverized.

The finely divided semi-coke is mixed with several per cent of briquet pitch and thoroughly blunged in a direct steam-heated mixing machine. The hot pitched coke is fed into a briquetting machine of the roller type giving about two hundred and fifty briquets to the revolution. In Fig. 3 this machine is shown in operation. A conveyor carries the steaming green briquets to a hopper above the inclined retort feed doors. Fig. 4 shows an exposed retort during construction and Fig. 5 a group of retort ovens, the roofed structure at the left being a vertical Glover West retort, and the others being a single and a triple bank of 35-degree inclined retorts. The inclined retort has proved most satisfactory, the finished briquets discharging by gravity to a coke carriage in which they are quenched. The degree of carbonization in the inclined retorts could be carried to any predetermined extent, so that any amount of volatile matter can be left. Up

CONDENSING THE VOLATILES

In the low temperature retorting of the pulverized coal, the average contents of the retort are constant, because of the continuous feed. The evolution of gases is strongest at the discharge end, so that an additional outlet is connected with the gas main in conjunction with a central connection. A water seal is placed in the line at a considerably lower level than in gas practice, so that a shallower dip with a corresponding decrease in resistance to flow of gas and less back pressure in the retort is obtained. The hot gases are freed of solids and liquids as in ordinary gas practice. Table I indicates the main divisions of the products and their amounts.

TABLE I—PRODUCTS OF THE CARBOCOAL PROCESS

Coal, 2,000 lb.	Carbocoal briquets, 1440 lb.	Tar oils, 250 lb.	{ Benzol, toluol, naphthas, motor spirits, cresote oils, tar acids, lubricating and fuel oil, pitch and other tar oil products.
	Vapors, 360 lb.		
	Ammonia, 20 lb.	Permanent gases required in the distillation process for heat, 200 lb.	{ Ammonia (concentrated), sul- phate of ammonia, cyanogen, pyridine bases, and other nitro- gen compounds.
	Gases and vapors, 560 lb.		

THE TAR AND ITS PRODUCTS

The tar obtained in the primary distillation of the coal has a specific gravity of 1 to 1.06, due to its large content of oils. A peculiarity of this tar is that it contains no naphthalene, anthracene or carbolic acid, but is rich in oils, tar acids and cresols which would indicate that the former are products formed from the

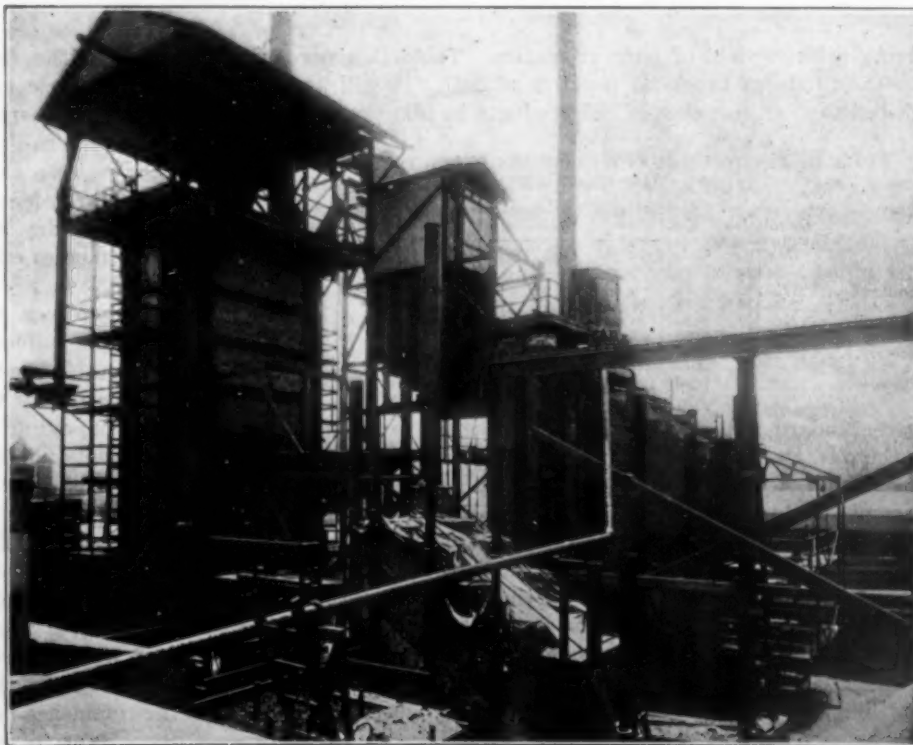


FIG. 5. EXPERIMENTAL RETORTS AT NEWARK, N. J.

latter under higher temperature conditions. Chart I gives a diagrammatic view of the coal tar industry and a partial list of the immense number of commercial products derived from it. From being an undesirable waste product, it is rapidly advancing to be an absolute necessity, with an unlimited consumption for its products.

In obtaining a high yield of benzol and toluol, the light condensates are passed through long, highly heated tubes, where the gas retort wall effect is reproduced.

THE FUTURE OF COAL CARBONIZATION

A large, low-temperature coal distillation plant is now being built at Clinchfield, Virginia. The Government is backing the Smith process there with a view to getting coal-tar oils for the manufacture of explosives and a fuel for the Navy that is as flexible and smokeless in combustion as fuel oil. Carbocoal is considered to have been sufficiently advanced beyond the experimental stage at the Newark plant to justify going into a larger

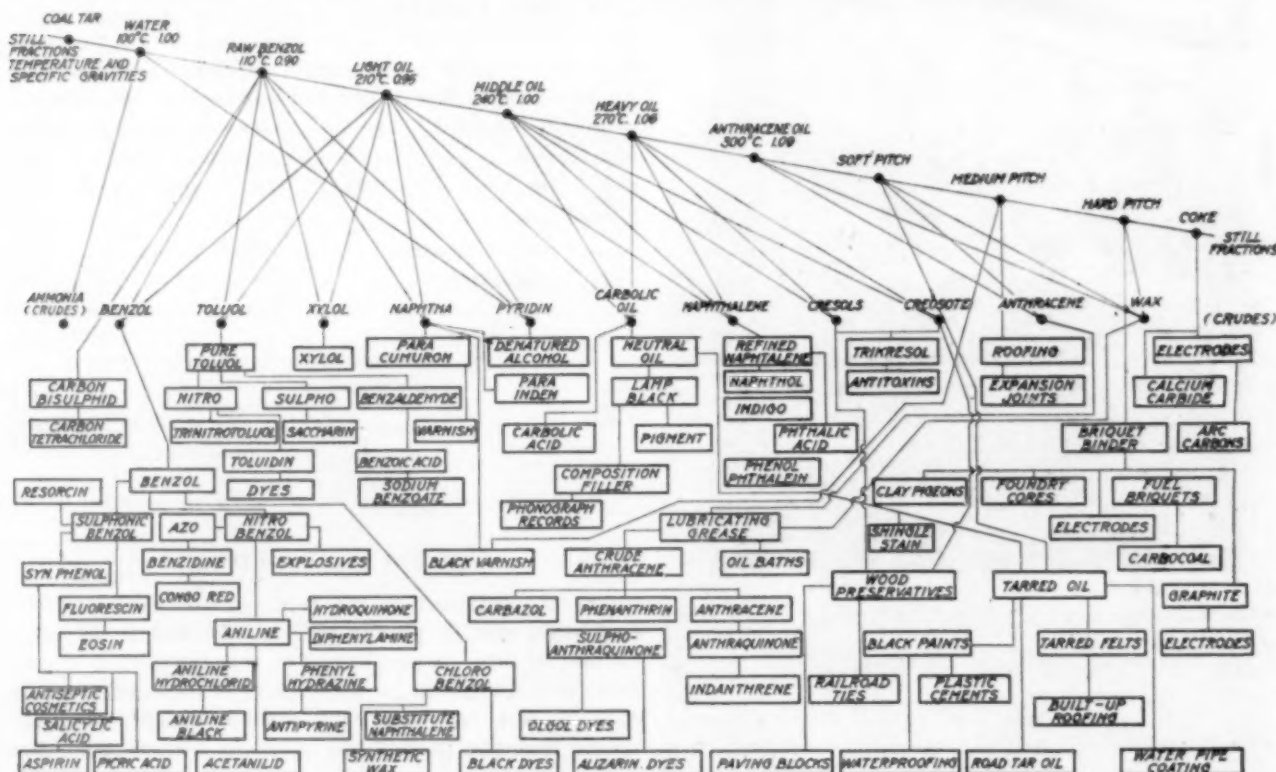


CHART I.—PRIMARY TAR FRACTIONS AND THEIR COMMERCIAL PRODUCTS

giving a large yield of pure aromatics. Table II gives the tar products produced per ton of coal. It will be noticed that an increase of the products in this process

TABLE II.—RECOVERY OF LIQUID PRODUCTS PER TON OF RAW COAL

Distillation Temperature, Deg. F.	By-Product Coke Oven		Carbocoal, First Distillation		Carbocoal, Second Distillation	
	Gal.	Per Cent	Gal.	Per Cent	Gal.	Per Cent
Light oil..... 0-170	0.27	3.47	1.58	6.60	0.083	0.05
Middle oil..... 170-230	0.44	5.65	3.29	13.70	0.036	0.60
Creosote oil..... 230-270	0.78	10.37	3.11	12.95	0.126	2.10
Heavy oil..... 270-360	1.26	16.81	8.88	37.00	2.485	41.42
Pitch.....	4.66	62.18	6.90	28.75	3.290	54.83
Loss.....	0.09	1.32	0.24	1.00	0.060	1.00
Totals.....	7.50	100.00	24.00	100.00	6.000	100.00

over standard by-product coke-oven practice is mainly in the oils, the factors being: light oil, 6; middle oil, 8; creosote oil, 4; heavy oil, 9; and pitch, 2. Without subsequent cracking, there will be a considerable percentage of paraffin oils, but as the supplies of benzol etc. from other sources will soon be more than can be consumed in the chemical industries, these oils will probably be used direct as solvents and motor fuel. The pitch will be low in free carbon, so that if used by itself, it would have a rather high temperature susceptibility (i.e. soften rapidly with heat); however, it can be compounded with the coke oven tars to give very satisfactory products.

undertaking. If the final outcome is as anticipated, Carbocoal will release vast amounts of petroleum fuel, will furnish great quantities of coal tar products, and if developed to its full possibilities, will aid immensely in giving our cities a clear sky line and an atmosphere unpolluted by tar. Mention might also be made that the saving in laundry soap might not be a negligible item in the economies effected.

Upon a brief survey of the possibilities presented in this coking process, the main items aside from the advantages of the refined carbocoal are the demand for motor engine fuel, road tars and creosote oils. Undoubtedly, the prices of these commodities shall advance to a point commanding sufficient production to equal their requirements. The ten per cent consumption of raw material for fueling the process is not a large expenditure. The cost accountant probably will have no difficulty charging the major products alone with all the manufacturing costs. The waste of the beehive coke ovens has been spoken of on the platform and in the press for years. Now that great things have been accomplished with by-product coke ovens, the sequence is naturally to extend their scope. Should the results warrant the confidence now reasonably put in the Smith process, the extent to which the coal tar industry can grow is unbounded.

The Metallography and Heat-Treatment of Metals Used in Aëroplane Construction—V

Results of Tests to Determine the Best Brazing Materials and Fluxes—Strength of Brazed Joints—Beneficial Effect of Heat Treatment—Comparison of Brazed and Welded Joints

By F. GROTTES

Chief Metallurgist Curtiss Aëroplane and Motor Corp.

INVESTIGATION OF BRAZING MATERIALS

THE object of this investigation was to determine (a) the best metal for making brazed joints between milled steel fittings, and (b) the best flux for the same. The materials used were various copper alloys and different fluxing materials.

Cold-drawn steel bars 8 in. long and $\frac{1}{2}$ in. hexagon cross-section were butt-brazed, and the tensile strength of the joints taken. In a certain number of cases experiments were repeated with different fluxes; in others the brazed bars were subjected to heat-treatment. The brazing in a part of the series was done with an oxy-acetylene torch; in the other cases, with a fire produced by two gas blow-pipes so adjusted that the tips of the inner flame touched the metal.

In the first series of experiments joints were made with five different brazing metals by means of the acetylene torch, one each with a mixture of five parts boracic acid and one part borax mixed to a paste with water and applied wet to cold metal, and with zinc chloride similarly applied. The resulting tensile

TABLE I. STRENGTH OF BUTT-BRAZED JOINTS

Exp. No.	Brazing Metals	Boric Acid Flux—		Zinc Chloride Flux	
		Load	Lb. Sq. In.	Load	Lb. Sq. In.
1	Wire 116-1	6,840	31,500	2,590	11,900
2	Wire 116-2	6,410	29,500	3,070	14,100
3	Wire 116-3	7,650	35,000	1,900	7,700
4	Wire 116-4	6,760	31,000	3,170	14,400
5	Wire 116-5	6,880	31,750	3,000	13,800

strengths are given in Table I. With zinc chloride the joints were only partially covered with braze, and the flow was very poor. Preliminary experiments with quartz sand, sodium carbonate, and a mixture of the two gave negative results.

The melting points and compositions of the five different samples of brazing wire are given in Table II.

TABLE II—MELTING POINTS AND COMPOSITION OF BEARING METALS

Wire	Melting Point	Copper, Per Cent	Zinc, Per Cent	Tin, Per Cent	Iron, Per Cent	Impurities, Per Cent
116-1	1,590	56.76	42.18	0.45	Trace	0.6
116-2	1,610	60.18	39.07	.....	0.1	0.65
116-3	1,614	59.22	39.61	0.27	.....	.....
116-4	1,603	66.52	32.78	.....	Trace	0.70
116-5	1,602	60.70	38.45	.....	0.1	0.75

Joints made by means of the acetylene torch, using the boric acid and borax mixture as flux, and various brazing metals, gave the results shown in Table III.

TABLE III—RESULTS OF BRAZING WITH VARIOUS METALS

Exp. No.	Brazing Metal	Load	Lb. Sq. In.
6	Brass No. 128-1	5,990	27,500
7	Brass No. 126-2	6,170	28,400
8	No. 128-3	6,220	28,600
9	Copper and brass equal parts	6,790	31,300
10	Copper 2 pt. Brass 1 pt.	7,050	32,500
11	Copper, sheet	6,870	31,800
12	Scrap and brass	670	3,090
13	Spelter (condemned)	9,080	41,800

Six joints made in the gas fire with sheet copper gave the results shown in Table IV.

TABLE IV—RESULTS OF BRAZING IN GAS FIRE WITH SHEET COPPER

Exp. No.	Metal	Load	Lb. Sq. In.
22		7,300	33,700
23		6,500	29,800
24		8,190	38,200
25		7,650	35,200
26		8,650	39,800
27		2,800	21,000
Average.....		7,186	33,200
28	116-1	9,370	43,100
29	116-2	6,980	32,100
30	116-Soft	10,550	47,500
31	116-4	9,700	44,600
32	116-5	10,970	50,500*
33	128-3	10,690	49,300
34	11-Tobin	10,720	49,400
35	10-Soft	10,990	50,000*

* Steel parted.

Joints made by use of acetylene torch with three different silver solders were tested, with results given in Table V.

TABLE V—TEST OF JOINTS MADE WITH SILVER SOLDER

Exp. No.	Metal	Load	Lb., Sq. In.
36	Silver No. 1	8,590	39,500
37	Silver No. 2	10,020	46,000
38	Silver No. 3	11,561	53,200*

* Steel parted.

CONCLUSIONS ON INVESTIGATION OF BRAZING MATERIALS

The joints brazed in the gas fire, using copper-zinc alloys with boric acid flux, nearly all exceeded the maximum strength of steel used.

Pure copper does not give as good results as alloys. It does not flow as well, and it is more difficult to produce a perfect joint with it.

With copper-zinc brazing alloys boric acid leaves little to be desired as a flux. It melts and flows freely, and dissolves the oxides readily. It is preferable to borax in that it is free from the frothing caused by the water of crystallization in commercial borax, and hence is easier to handle on the hot metal. It makes no difference how it is applied as long as a sufficient amount is fused on the joint to insure a complete cleaning of the metal.

STRENGTH OF BRAZED JOINTS; EFFECT OF HEAT-TREATMENT

The object of the investigation was to determine (1) the relative strength of joints brazed with brazing metal of different compositions (a) brazed with acetylene torch, and (b) brazed in a gas fire; and (2) to determine the effect of heat-treating on joints brazed with torch and with gas fire.

(1) Bars of cold drawn $\frac{1}{2}$ -in. hexagon steel were butt-brazed with different metals by the two methods of heating and the tensile strength of the joint taken.

(2) A series of bars as brazed, and one-half of them heat-treated by heating to 1600-1625 deg., quenching in oil and drawing at 900 deg., after which the tensile strength of the joints was taken.

Preparation of Brazing Metal. A brazing metal was made by melting together 6 lb. of copper and 1½ lb. of zinc under a borax flux, and allowing the melt to cool in the crucible. The ingot obtained was then sawed in two, and one of the halves remelted, and a bar made by pouring a portion into a mold. The ingot and the bar showed the following percentage composition by analysis:

	Copper	Zinc	Iron	Bismuth	Lead
Ingot	81.74	18.20	0.06	Trace	Trace
Bar	82.60	17.30	Trace	Trace	Trace

The bar was used to make twelve joints each with the acetylene torch and the gas fire; and one-half of each of these sets was heat-treated.

The tensile strengths were then taken with results shown in Table VI. Increase in strength of torch braise,

TABLE VI. STRENGTH OF COPPER-ZINC BRAZED JOINTS

Exp. No.	—Torch Braise— Load Lb. Sq. In.	Exp. No.	—Fire Braise— Load Lb. Sq. In.
39	10,190	45	7,150
40	7,800	46	9,610
41	9,070	47	9,470
42	10,190	48	11,280*
43	6,880	49	7,150
44	10,420	50	7,660
Average.....	43,416	Average.....	40,050

* Steel parted.

average 3366 lb. sq.in., 8.4 per cent; minimum strength, torch 35,800; fire, 32,900; excess of torch, 2900 lb. sq.in., 8.8 per cent.

The bars that were heat-treated after the brazing gave the results shown in Table VII. Average increase

TABLE VII—EFFECT OF HEAT-TREATMENT ON BRAZED JOINTS

Exp. No.	—Torch Braise— Load Lb. Sq. In.	Exp. No.	—Fire Braise— Load Lb. Sq. In.
51	10,280	57	9,130
52	12,220	58	8,580
53	10,980	59	8,550
54	9,380	60	10,030
55	10,820	61	8,960
56	10,360	62	7,950
Average.....	48,650	Average.....	40,800

of heat-treated over untreated: torch, 5234 lb. sq.in.; fire, 750 lb. sq.in.; per cent increase, torch 12 per cent., fire 0.2 per cent.

A metal was made by melting together 85 parts of copper and 15 parts zinc, remelting and ingot and casting a bar which analyzed 87 per cent copper and 12.4 per cent zinc. With this metal used in a fire braise on the hexagon rods, results were obtained as given in Table VIII. The results showed such inferiority that no further test was made with this metal.

TABLE VIII—TESTS OF COPPER-ZINC BRAZING METAL

Exp. No.	Load	Lb. Sq. In.
63	6,790	31,200
64	6,860	31,600
65	8,020	37,000
66	6,700	30,800
67	7,970	36,800
68	8,630	39,800

A metal made by melting together 305 g. copper, 62 g. zinc and 4 g. tin gave results, with a fire braise, shown in Table IX. These results did not warrant further tests of this metal.

TABLE IX—TESTS OF COPPER-ZINC-TIN BRAZING METAL

Exp. No.	Load	Lb. Sq. In.
69	6,760	31,000
70	6,910	31,900
71	5,780	26,800
72	6,970	32,000
73	6,760	31,100
74	7,430	39,100

CONCLUSIONS ON STRENGTH OF BRAZED JOINTS

Joints made with the acetylene torch were distinctly stronger than those made in the gas fire.

The brazing metal containing 83 per cent copper and 17 per cent zinc gave strongest joints.

Heat-treatment of the joints acetylene-brazed gave a marked increase in strength.

Remarks. The results obtained demonstrated that it is practical to make brazed joints that will be materially improved by heat-treating the steel after brazing. Brazing metal containing from 20 per cent to 15 per cent zinc has a sufficiently high melting-point to admit of heat-treatment and flows well in operation.

INVESTIGATION OF BRAZED AND WELDED JOINTS

The object of this investigation was to determine the effects of heat-treatment on joints brazed with different brazing metals, and a comparison of the relative strength of brazed and acetylene-welded joints.

Materials. Cold-drawn seamless steel tubing, and brass and copper for brazing metal.

Sections of tubing were cut 6 in. long. These were respectively 1 in. and ½ in. outside diameter and both of 16 gage. The larger diameter pieces were cleaned out at one end by means of a reamer, and the ends of the smaller pieces were cleaned off by filing in the lathe. This preparation provided joints free from scale and also permitted the smaller tube to telescope the larger with a free fit. Fifty pairs of these tubes were prepared, comprising five series of experiments of ten each:

- (A) Dip-brazed, with standard brazing brass
- (B) Gas-brazed, with standard brazing brass
- (C) Oxyacetylene-brazed, with standard brazing brass
- (D) Oxyacetylene-brazed, with pure copper
- (E) Oxyacetylene-welded

One-half, i.e., 5 pairs of each series (except A, all of which were heat-treated by mistake) were heat-treated after brazing, by heating to 1600 deg., oil quenching, and drawing to 900 deg.

In each series a part of the joints were ⅜ in. length, i.e., the smaller tube telescoped the larger ⅜ in.; a portion were ½ in., and the remainder ¾ in.

Boric acid was used as the flux.

After the joints were made and heat-treated, the pieces were cleaned by sandblast and any fillets that had been formed were filed away.

Series B and C were brazed with the brass described in the previous report, containing 82.6 per cent copper and 17.3 per cent zinc, which is practically the composition of the government specification brazing metal. Series A was made with a metal not substantially different. A piece of copper tubing was used in Series D.

The completed pieces were subjected to test for tensile strength. The results are given in Tables X, XI, XII, XIII and XIV.

TABLE X—SERIES A, DIP-BRAZED, STANDARD BRASS

Not Heat-treated				Heat-treated			
Exp. No.	Joint In.	Yield Point, Lb.	Ultimate Strength, Lb.	Exp. No.	Joint In.	Yield Point, Lb.	Ultimate Strength, Lb.
75	⅜	.....	3,910*	80	⅜	.....	5,770*
76	⅜	8,300	10,760	81	⅜	8,120	10,810
77	⅜	.....	10,860	82	⅜	8,333	10,870
78	⅜	.....	9,660*	83	⅜	.....	10,970
79	⅜	.....	9,250*	84	⅜	.....	11,030*

Average 9,400; min. 3,910.

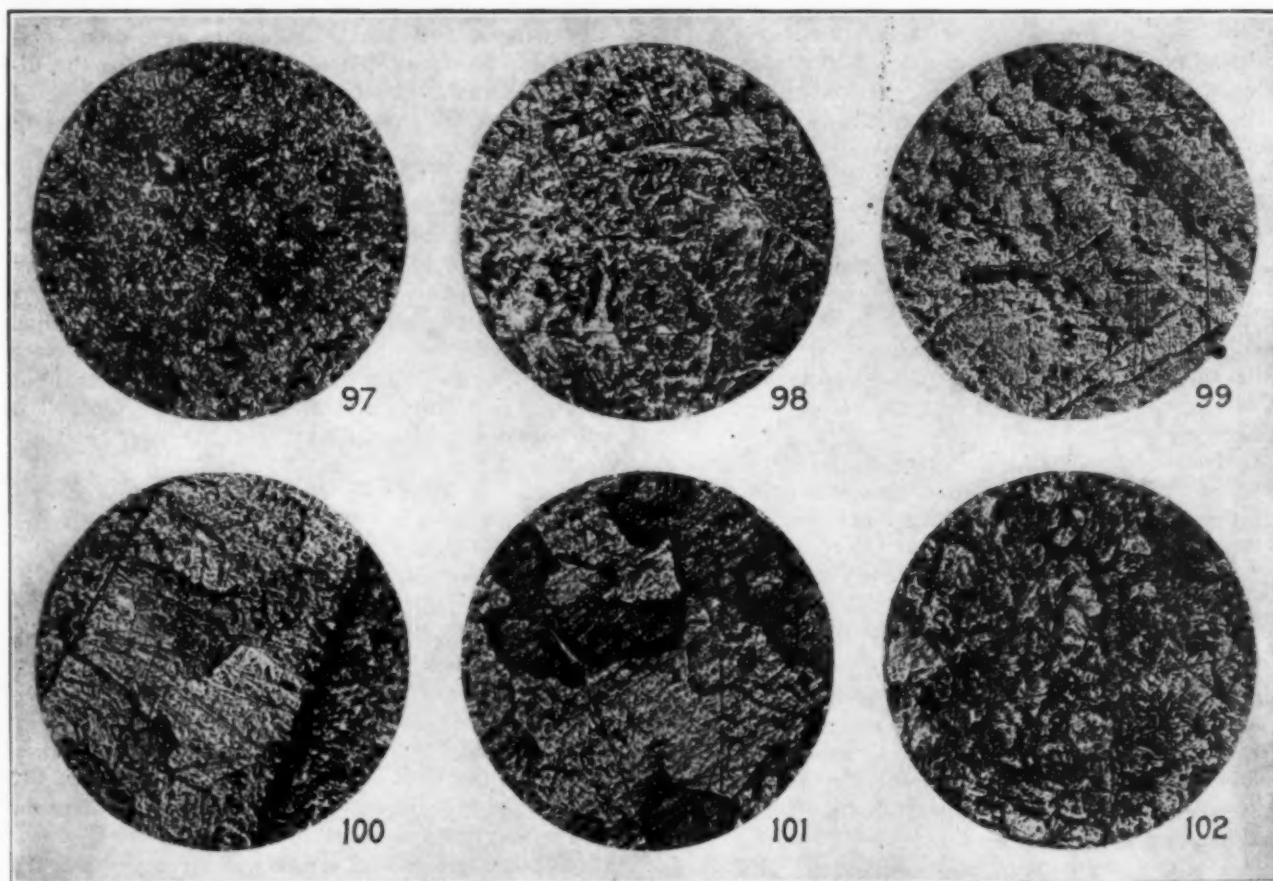
* Joint pulled apart.

TABLE XI—SERIES B, BRAZED IN GAS FIRE, STANDARD BRASS

Not Heat-treated				Heat-treated			
Exp. No.	Joint In.	Yield Point, Lb.	Ultimate Strength, Lb.	Exp. No.	Joint In.	Yield Point, Lb.	Ultimate Strength, Lb.
85	⅜	5,910	9,600	90	⅜	.....	11,680
86	⅜	.....	9,400	91	⅜	7,950	11,520
87	⅜	.....	9,770*	92	⅜	.....	9,350*
88	⅜	.....	5,050*	93	⅜	.....	3,560*
89	⅜	.....	8,430*	94	⅜	.....	7,500*

Average 8,580; min. 3,560.

* Joint pulled apart.



FIGS. 97 TO 102

Fig. 97—Joint made with acetylene torch. Fig. 98—Joint made with gas torch. Figs. 99 to 102—Welds and brazes. Heat treatments given 1600-1625 deg.; quenched in oil and drawn at 1000 deg.; $\times 100$. Fig. 99—Untreated joint, picric acid etch; 100—Treated brazed joint; 101—Untreated weld, picric acid etch; 102—Treated weld.

TABLE XII—SERIES C, BRAZED WITH OXYACETYLENE TORCH, STANDARD BRASS

Untreated				Heat-treated			
Exp. No.	Joint In.	Yield Point, Lb.	Ultimate Strength, Lb.	Exp. No.	Joint In.	Yield Point, Lb.	Ultimate Strength, Lb.
95	✓	9,850*	100	✓	.....	11,320*
96	✓	10,340*	101	✓	.....	11,260
97	✓	10,230	102	✓	.....	11,750
98	✓	11,750	103	✓	.....	12,380
99	✓	10,370	104	✓	8,850	9,540*

Average 11,679; min. 9,540.

* Joint pulled apart.

TABLE XIII—SERIES D, BRAZED WITH ACETYLENE TORCH, PURE COPPER

Untreated				Heat Treated			
Exp. No.	Joint In.	Yield Point, Lb.	Ultimate Strength, Lb.	Exp. No.	Joint In.	Yield Point, Lb.	Ultimate Strength, Lb.
105	✓	7,050	8,200	100	✓	.....	10,390*
106	✓	7,210	10,100*	111	✓	7,880	8,290*
107	✓	10,200	112	✓	.....	10,660
108	✓	10,000	113	✓	.....	11,050
109	✓	8,100*	114	✓	.....	10,930

Average 9,792; min. 8,100.

* Joint pulled apart.

TABLE XIV—SERIES E, OXYACETYLENE WELDED

Untreated				Heat Treated			
Exp. No.	Joint In.	Yield Point, Lb.	Ultimate Strength, Lb.	Exp. No.	Joint In.	Yield Point, Lb.	Ultimate Strength, Lb.
115	✓	8,280*	120	✓	.....	8,280*
116	✓	8,610*	121	✓	8,840	9,180*
117	✓	6,900	10,200*	122	✓	.....	10,400*
118	✓	10,000*	123	✓	.....	10,800*
119	✓	10,131*	124	✓	.....	11,260*

Average 8,936; min. 8,280.

* Joint pulled apart.

The 1-in. tubing alone, without any treatment, gave a yield point of 8,760, and ultimate strength of 9,550 pounds.

A pair of tubes, brazed with the acetylene torch, meeting but not telescoped, the joint consisting only of a

fillet flush with the larger tube gave a yield point of 7000 and ultimate strength of 10,390 lb., the smaller tube parting, leaving the joint intact.

CONCLUSIONS ON BRAZED AND WELDED JOINTS

(1) The best brazed joints, all points considered were obtained with standard brazing metal, made with the acetylene torch and heat-treated. The joints showed (a) the highest average ultimate strength, (b) the highest minimum strength (c) the highest yield point, and (d) the smallest proportion pulling apart at the joint.

(2) The methods of brazing, considered with reference to the above points, ranked as follows: (a) acetylene torch, (b) dip, (c) gas fire.

(3) The best brazing metal was the standard brass.

(4) All welded joints were weaker than the ultimate strength of the tubing.

(5) The average strength of heat-treated brazed joints was 9.6 per cent higher than that of the untreated.

(6) In only one case did a brazed joint formed by a lap of 1 in. pull apart, and in that case the ultimate strength was over 11,000, which is considerably above the normal strength of the tubing.

Remarks. In the case of brazed joints made under the best conditions, as previously described, with steel that has been subject to cold-working, as drawn tubing or cold-rolled sheet, and untreated the weakest part is the steel above the joint where it is subjected to the heat of the flame during the brazing process. The 100

per cent efficient brazed joint is therefore entirely practical, and could probably be substituted to advantage in many cases where welding is now practiced.

The superiority of brazing done by the acetylene torch over that done with a gas fire was referred to previously; further experiments confirm those conclusions.

The greater strength of the joints made by the acetylene torch are apparently due to a difference in the physical condition of the metal. Micrographs of joints made with the same metal by the two different methods of heating show marked variations in structure, that made with the acetylene torch having a very fine grain, while the other shows a coarse crystalline structure, as will be seen by reference to Figs. 97 and 98 respectively.

Analysis of the metal in joints made in the same series of experiments shows that the acetylene torch reduces the zinc content of the metal 6 per cent, while the gas fire reduces it only 2 per cent.

	Copper	Zinc
Composition of metal before brazing.....	82.6	17.3
Composition of metal after acetylene-brazing.....	88.8	11.2
Composition of metal after gas fire-brazing.....	84.6	15.4

The difference in composition, however, does not account for the difference in strength; in fact, the reverse would be expected, since the strength of copper-zinc alloys normally decreases as the zinc content decreases through this range of proportions. Joints brazed with a metal of almost identical composition to the acetylene joint showed very inferior strength. (See experiments 63-68.) It seems probable that as a result of the conditions produced by the acetylene torch, beta crystals of copper-zinc solid solution are formed which remain after cooling. The fact that these joints show a pink color on fracture (Fig. 97), while the others have the pure yellow color of the alpha crystals (Fig. 98) tends to confirm this opinion. Whatever the cause, there is no doubt that the torch-brazed joints are stronger, and that their strength is further increased in the process of heat-treating the steel.

FURTHER INVESTIGATION OF BRAZING VS. WELDING

The object of this series of tests was to determine:
(1) The relative strengths of brazed and welded joints;
(2) the effect of heat-treating on brazed joints; and
(3) the effect of heat-treatment on welded joints.

Materials. Strips of cold-rolled sheet steel, 7 in. x 0.925 x 0.1; brass containing 87 per cent copper; boric acid flux, and still wire for welding.

Method. Ten pairs of steel strips were butt-brazed with the acetylene torch, and ten pairs butt-welded, the work being done carefully by experienced workmen. One-half each of the brazed and welded bars were then given the prescribed heat-treatment for this grade of steel, viz.: heating to 1600 to 1625 deg., quenching in oil,

TABLE XV—TENSILE STRENGTH OF BRAZED AND WELDED JOINTS (Pounds maximum load)

Brazed				Welded			
Exp. No.	Un-treated	Exp. No.	Treated	Exp. No.	Un-treated	Exp. No.	Treated
125	5,160	130	6,270	135	4,060	140	5,220
126	5,015	131	5,995	136	4,295	141	5,685
127	4,370	132	6,270	137	4,985	142	6,420
128	5,370*	133	5,635	138	3,670	143	5,460
129	5,120*	134	6,410	139	5,040*	144	5,550
Average load, 5,000	...	6,165	...	4,400	...	5,667	...
Average per sq. in., 54,000	...	66,400	...	47,500	...	61,200	...

* Steel bar faulted.

and drawing at 900 deg. All the bars were then sand-blasted, and the joints carefully filed down to the dimensions of the bar, after which they were subjected to tests for tensile strength, with the results given in Table XV.

Comparative Strengths Based on Averages. Untreated brazed joint is 22.7 per cent stronger than untreated welded joint. See Figs. 99 and 101.

Treated brazed joint is 40 per cent stronger than untreated welded joint. See Figs. 100 and 101.

Treated brazed joint is 8.8 per cent stronger than treated welded joint. See Figs. 100 and 102.

Effect of Heat-Treatment. The treated brazed joint is 23.3 per cent stronger than the untreated joint. The treated welded joint is 28.8 per cent stronger than untreated joint.

Comparative Strengths Based on Minimum Loads. Untreated brazed joint is 19.2 per cent stronger than untreated welded joint.

Treated brazed joint is 55 per cent stronger than untreated welded joint.

Treated brazed joint is 7.8 per cent stronger than treated welded joint.

Treated brazed joint is 29.5 per cent stronger than untreated joint.

Treated welded joint is 42.3 per cent stronger than untreated joint.

Two out of five untreated brazed joints were stronger than the maximum strength of the steel.

One out of five welded joints was stronger than the maximum strength of the steel.

None of the treated joints were as strong as the steel, showing that heat-treatment strengthens the steel in a greater proportion than it does either the brazed or welded joint.

All of the brazed joints exceeded in strength the yield point of the untreated steel; all but one of the welded joints exceeded the yield point of the steel.

Conclusions. On every basis of comparison, in average, minimum, and maximum strength, the brazed joint proved stronger than the welded joint; and in both kinds of joints heat-treating produced a marked increase in strength.

Remarks. In these experiments the welding was done under the most favorable conditions for producing a good joint; the pieces were thin enough so that there was no difficulty in heating the joint up to welding temperature, and they were welded on both sides. The brazing conditions were hardly as favorable as the average.

The beneficial effect of heat-treatment of brazed joints confirms the results of former experiments, and leaves no room for doubt of the correctness of the conclusions.

Producer-gas tar or oil is washed with alcohol at a moderate temperature. Air is blown through, forming oxygenated products which are dissolved by the alcohol. The alcohol layer and the undissolved portion are separated and both freed from spirit. The oxygenated products are left as heavy viscous liquid suitable for lubricating wagon axles. The undissolved portions are lighter and can be fractionated into motor spirit and lubricating oil. The necessity for washing with sulphuric acid, with its attendant losses and inconveniences is avoided. D.R.P. 302,398.

Aluminium and Its Light Alloys—IV

Binary and Ternary Alloys—Conditions Favorable for Casting—Effect of Pouring Temperature on Tensile Strength—Alloys for Rolling and Forging

BY PAUL D. MERICA

A VERY comprehensive investigation of the mechanical properties of rolled, binary light alloys of aluminium was carried out in 1915 by Schirmeister (341).

Schirmeister rolled out several compositions of many binary alloys systems of aluminium and tested their hardness and tensile strength. His method of preparation for the alloys was the same for all series and was as follows:

About 900 grams of the alloy was melted in a small gas crucible furnace, poured into a chill mould to plates 25 mm. thick. These were rolled in a 30 hp. mill at the rate of 40 meters per minute. The plates were first reheated after casting to from 400 to 500 deg. C. and rolled with intermediate annealing, with reduction at each pass of from 1 to 3 mm. to a thickness of 4 mm. They were then annealed and rolled cold to from 1.3 to 1.5 mm. thickness. Only those alloys of which the melting point was very considerably lowered by the additions were rolled at lower temperatures or cold. Specimens cut from these sheets were then annealed at from 300 to 370 deg. in a muffle furnace, allowed to cool, and tested after several days.

His results are given in the Table XIV (pg. 588).

9. EQUILIBRIA, BINARY AND TERNARY

In Table XV are described the equilibria for binary systems of aluminium as far as they are known; references are given for binary and ternary systems.

It is observed that most metals form compounds with aluminium; the solubility of the aluminium rich compound in the solid aluminium is generally almost zero. The three prominent exceptions to this fact are zinc, copper, and magnesium.

The light alloys of aluminium with these metals contain only small quantities of the added metal, as with increasing amounts the alloy quickly becomes brittle.

Metallographically the light alloys are usually heterogeneous, with a ground mass of almost pure aluminium and crystals of the compound of aluminium with the added metal; these are hard, brittle and more resistant to corrosion than aluminium.

10. COMMERCIAL ALLOYS

From the practical standpoint of the relative value of the various alloys which have been studied, the re-

TABLE XV. EQUILIBRIUM DIAGRAMS OF ALUMINIUM ALLOYS

Alloy System	References (1)	Composition of Aluminium-Rich Compound	Melting Point of Aluminium-Rich Compound, Deg. C.	Eutectic with Aluminium-Rich Compound, Temperature, Deg. C.	Per Cent	Solubility in Aluminium-Rich Compound Per Cent of Metal	Compound Formed
Aluminium and:							
Antimony	Mathews, Campbell and Mathews (387), Tannmann (415)	SbAl	1065	655	....	Nearly zero (1)	SbAl
Calcium	Donaki (364)	CaAl ₂	....	610	5.6	Nearly zero (1)	CaAl ₂
Chromium	Hindricks (371)	AlCr ₃ (?)	....	645	1 (?)	Nearly zero (1)	AlCr ₃ (?)
Cobalt	Gwyer (366)	Co ₂ Al ₁₁	(2)	630	5	Nearly zero (1)	Co ₂ Al ₁₁
Copper	Gwyer (378), Carpenter & Edwards (380), Curry (382)	Al ₂ Cu	(2)	545	32	About 4	Al ₂ Cu
Gold	Haycock and Neville (359, 360)	Al ₂ Au	1150	647	1.1	Nearly zero (1)	Al ₂ Au ₂ , Al ₂ Au ₃ , AlAu ₂ , Al ₂ Au
Iron	Gwyer (378)	FeAl ₃	1150	649	1 (?)	Nearly zero (1)	FeAl ₃
Magnesium	Grube (402)	Mg ₂ Al ₃	463	453	35	About 1	Mg ₂ Al ₃
Manganese	Hindricks (405)	Al ₂ Mn	....	649	3 (?)	Nearly zero (1)	AlMn ₂ (?), Al ₂ Mn (?)
Nickel	Gwyer (409)	NiAl ₃	(2)	630	6	Nearly zero (1)	NiAl ₃ , NiAl ₂ , NiAl ₂
Silver	Gautier, Pitrenko (357)	Ag ₂ Al	....	567	30	Nearly zero (1)	Ag ₂ Al, Ag ₂ Al ₂
Zinc	Lorenz & Plumbridge (436), Rosenhain & Archbutt (438)	Al ₂ Zn ₃	(2)	380 (3)	95 (3)	20-40	Al ₂ Zn ₃
Cerium	Vogel (366)	CeAl ₃	....	638	10	Not known	Ce ₂ Al, Ce ₂ Al ₂ CeAl, CeAl ₂ , CeAl ₃
Platinum	Chourigine (413, 414)	PbAl ₃	....	639	9	....	PbAl ₃
Vanadium	Czako (431)	VAl ₂	....	....	....	....	....
(1) Not determined.							
(2) Decomposes before fusing.							
(3) Eutectic of zinc—Zn, Al ₂ .							
(4) Latest references are given, but not all, as earlier ones are always noted in the former.							
(B) The metals are not miscible or only slightly so in the liquid state.							
Alloy System	References						
Aluminium and:							
Bismuth	Gwyer (362)						
Cadmium	Gwyer (365)						
Lead	Gwyer (411)						
Potassium	Mathewson (393)						
Sodium	Mathewson (393)						
(C) The metals form a simple eutectiferous series.							
Alloy System	References						
Aluminium and: Temperature							
Silicon	Roberts (417), Fraenkel (420)						
Tin	Gwyer (424), Shepherd (425), Campbell & Mathews (428), Lorenz & Plumbridge (423)						
(D) Ternary Systems.							
System	References						
Al-Mg-Zn	Eger (462)						
Al-Cu-Zn	Carpenter and Edwards (465)						
Al-Mn-Cu	Rosenhain and Lantberry (466)						
Al-Cu-Sn	Andrews and Edwards (467)						

strength is one of aluminium-zinc-copper developed by Rosenhain & Archbutt (438).

CASTING AND DIE-CASTING

Pure aluminium is but rarely used in the cast form, owing to its softness, high shrinkage and poor machining qualities. Its alloys, however, with zinc, copper or magnesium or combinations of these are excellent and give with proper care very good castings.

In general the casting practice for aluminium alloys follows that for brasses and bronzes. The alloys may preferably be melted in ordinary graphite crucibles in either oil, gas, coke or coal furnace; care should be taken not to overheat the metal as it then oxidizes, absorbs gases and may at higher temperatures absorb carbon and silicon from the crucible. Good practice favors keeping the temperature of the metal during melting practically at its melting point by the continuous addition of solid metal. Pouring should be done at the lowest temperature at which the metal will completely fill the mold; a temperature of 700 deg. C. or below is satisfactory. A low pouring temperature is particularly important for aluminium castings because of the high specific heat of the metal; if poured at a high temperature the metal in cooling heats the mold so hot that the rate of cooling is very slow; a coarse grain and weak metal result.

No flux should be used in melting down, and the surface should not be covered with carbon, as this may be included in the casting. Just before pouring, however, a small amount of zinc chloride may be added with advantage. This thoroughly cleans the surface, and prevents dross from entering the casting.

In molding castings to be poured in aluminium alloy, two characteristics of the material should be borne in mind:

(1) The metal and its alloys are quite brittle or "hot short" and fragile at temperatures just below the melting point, and (2) they are light. Consideration of the first fact means that the mold or cores should not be too hard. Ordinary green sand, not too fine, is to be recommended and hard ramming is to be avoided. A large percentage of bad castings are probably due to non-adherence to this principle.

The mold should be poured carefully and not too rapidly as the metal may otherwise fail to fill finer parts of the mold. The casting should be stripped as soon as set in order to prevent cracking. Owing to the lightness of the alloys chaplets are rarely needed in anchoring cores.

Commercial casting alloys may be obtained in ingot form and it is perhaps in general best to use such material. If the metals are alloyed in the foundry, a hardener should first be made containing from 10 to 50 per cent of the alloying constituent. In melting down, this hardener is first melted and the aluminium then added.

For the usual alloys 0.156 in. per foot is accepted as the pattern-maker's allowance for shrinkage; for aluminium, this is 0.203 in. per foot.

Re-melting of aluminium. The re-melting of scrap aluminium alloy in coarse form offers no particular difficulty, but that of borings and chips is extremely difficult (Gillett, 306) owing to the fact that each particle

is covered with an extremely tenacious coating of Al_2O_3 which effectually prevents its coalescence with its neighbor. Two remelting methods are in commercial use. In one, the chips are puddled in iron pots until a pasty mass of metal accumulates, which is then heated to a red heat until the dross and dirt rises, leaving clear metal. In the other the chips are mixed with a chloride and fluoride flux and melted in a crucible until the metal collects at the bottom. In a modification of this method (McKinney, 306) a low melting point chloride-fluoride flux is melted down in a crucible and the aluminium chips fed into it; the oxide is fluxed off of the chips which melt and collect at the bottom.

By these methods from 50 to 95 per cent recovery of metal is accomplished depending on the cleanliness of the chips. The metal should not be used except for unimportant castings of which the mechanical properties are not a prime consideration. Chips of magnalium, remelted by a method described by Coulson (395) gave much lower tensile strength than the original virgin metal and practically no ductility; the use of a de-oxidizer such as metallic calcium caused a partial recovery of the former mechanical properties.

A more recent development has been the practice of briquetting light scrap of aluminium alloy (Stillman, 299). Tests made showed a shorter melting time and a lower melting loss for remelted briquetted "aluminium" than for remelted chips (8.1 per cent as against 13.8 per cent melting loss).

Effect of casting section and of pouring temperature on mechanical properties. Gillett (316) has investigated the most important question of the effect of pouring temperature on the mechanical properties of aluminium alloy castings.

A heat of No. 12 alloy (see below) was poured at 703 deg. C. into test bars of different sizes. His test results are given in Table XVI. It is seen that the greater the cross section of the casting, the lower the resulting tensile strength.

TABLE XVI.
TENSILE PROPERTIES OF NO. 12 CASTING ALLOY
(Gillett)

A. Effect of casting section.
B. Effect of pouring temperature.

Size, In.	A. Area of Section, In.	Tensile Strength Lb. per Sq. In.
0.9 x 0.4	0.36	16,000
0.75 x 0.25	0.186	18,000
0.40 round	0.125	20,000
0.45 round	0.157	19,000
0.50 round	0.196	18,000
0.75 round	0.440	16,000
1.00 round	1.00	13,500

Temperature, Deg. F.	B.	Tensile Strength, Lb. per Sq. In.
1200		20,000
1250		19,500
1300		14,200
1350		18,500
1400		18,000
1450		17,800
1500		17,500
1550		17,000
1600		16,000

In part B of the same table are given Gillett's results on the effect of pouring No. 12 alloy into a (S.A.E.) cast-to-size test bar (0.5 in. in diameter) in green sand from different temperatures. The hardness decreases with increasing pouring temperature. Gillett tested the effect of pouring temperature on 53 alloys in all

(see Table XVII) and concludes that in general the alloys are weaker by approximately 20 per cent when poured hot (1550-1600 deg. F.) than when poured cold (1225-1250 deg. F.). His results on the different alloys are given in Table XVII. An exception was noted in

TABLE XVII.
EFFECT OF POURING TEMPERATURE ON THE TENSILE STRENGTH
OF LIGHT ALUMINIUM ALLOYS.
Gillett (316)

(The bars were presumably poured into the S.A.E. cast-to-size test bar, in green sand. Aluminium containing 0.3 per cent Fe and 0.2 per cent Si was used in the preparation of the alloys.)

Chemical Composition Per Cent	Pouring Temperature, Deg. C.	Tensile Strength, Lb. per Sq. In.	Pouring Temperature, Deg. C.	Tensile Strength, Lb. per Sq. In.
Pure Aluminium.....	760	10,500	871	8,000
Copper-Aluminium Alloys:				
2.....	668	13,800	871	11,500
4.....	668	15,500	871	13,000
6.....	668	17,600	871	14,500
8.....	668	20,000	871	15,500
10.....	668	21,000	871	16,000
12.....	668	22,500	871	17,500
Zinc-Aluminium Alloys:				
4.....	668	13,000	843	10,000
8.....	668	17,000	843	12,700
12.....	668	21,000	843	14,000
16.....	668	24,000	843	17,000
20.....	668	27,000	843	20,000
24.....	668	30,000	843	24,500
28.....	668	33,000	843	27,500
32.....	668	35,000	843	30,000
36.....	668	37,000	843	33,000
Copper-Zinc Aluminium Alloys:				
8.0 0.25.....	668	20,000	843	17,000
8.0 0.50.....	668	20,500	843	17,000
7.5 1.0.....	668	18,000	843	14,000
7.0 3.0.....	668	19,500	843	15,500
7.0 9.0.....	668	25,000	843	18,000
6.0 5.0.....	668	20,000	843	15,000
5.0 10.0.....	668	24,000	843	18,500
4.0 8.0.....	668	23,500	843	17,000
4.0 15.0.....	668	32,000	843	23,000
3.0 3.0.....	668	17,000	843	13,000
3.0 6.0.....	668	19,000	843	13,500
3.0 12.0.....	668	26,000	843	18,500
3.0 15.0.....	668	28,500	843	19,500
3.0 25.0.....	668	37,500	843	29,500
2.5 19.0.....	668	33,000	843	25,000
2.0 10.0.....	668	23,000	843	15,500
2.0 22.0.....	668	36,000	843	28,000
2.0 25.....	668	37,000	843	33,000
1.75 30.....	668	42,000	843	34,000
3.0 15.....	0.50 Mn. 668	30,000	843	20,000
Miscellaneous:				
Cu Mn Mg 2.0	649	19,000	843	18,500
8 0.25	676	20,500	760	20,000
7 0.33	649	20,000	814	17,500
6 0.50	676	18,500	814	16,000
4 1.0	676	16,000	814	15,000
8 Sn 2	657	18,000	802	15,750
5 Sn 3	657	16,800	814	15,000
6 Ni 1	703	18,200	871	14,500
8 Ti 0.25	676	19,000	814	18,400
8 Cr 0.25	649	19,500	814	15,900
8 Sb 0.25	676	20,000	814	17,400
8 Vd 0.25	676	20,000	814	18,500
8 Cd 0.25	676	18,600	814	15,800
8 Bi 0.25	676	18,000	814	14,000
4 Ag 8	703	19,700	843	15,400
8 1.5 Fe Si 0.75	676	21,000	814	18,000

the case of the 5 per cent magnalium and of the 2 per cent manganese alloy.

Rosenhain and Lantsberry (466) have studied the effect of pouring temperature on the tensile properties of a chill cast aluminium-manganese-copper alloy No. 10 (see Table XIII) and find the following results:

Pouring Temperature, Deg. C.	Tensile Strength, Lb. per Sq. In.	Elongation in 2 In., Per Cent
775-737	12,900	2
687-675	26,000	8
650	25,300	8

Other tests have been made by Donaldson (438, discussion), who finds a falling off in tensile strength and elongation between 800 and 850 deg. C. for an alloy of 19 per cent zinc and 1 per cent copper:

Pouring Temperature, Deg. C.	Tensile Strength, Lb. per Sq. In.	Elongation in 2 In., Per Cent
850	20,400	1.8
800	29,300	4.0
700	22,000	2.5

by Carpenter and Edwards (380) who give the following results for chill castings of an alloy of 4.63 per cent copper, balance aluminium:

Pouring Temperature, Deg. C.	Tensile Strength, Lb. per Sq. In.	Elongation in 2 In., Per Cent
650	21,700	8.5
724	15,700	5.5
707	10,900	3.0

and by Rosenhain (438, discussion), who contributes the following values for chill castings of an alloy of 20 per cent zinc and 1 per cent copper:

Pouring Temperature, Deg. C.	Tensile Strength, Lb. per Sq. In.	Elongation in 2 In., Per Cent
850	24,000	2.5
800	30,800	4.0
750	31,500	3.0
700	31,700	4.0
650	30,900	3.0

Die-casting. The term die-casting is rather vaguely understood to connote the casting of metal in metallic molds either with or without the mechanical application of pressure.

Die-castings may readily be made of aluminium alloys; the copper-aluminium alloys are particularly suitable for this class of work; aluminium-zinc alloys are difficult to handle because of their hot-shortness (Norton, 310). Norton describes the use by the Aluminium Castings Company of No. 12 alloy for this purpose. This metal gives castings which are of smooth surface, dense and dimensionally true within a very small margin (± 0.005 in.). Mechanical properties for die-castings of No. 12 average:

	Sand Castings	Die Castings
Tensile strength, lb. per sq. in.	20,000	25,000
Yield point (stress for 0.01 in. elong. in 2 in.), lb. per sq. in.	13,000	13,000
Elongation in 2 in., per cent	1.7	3.1
Density	2.84	2.87

Many articles are now die-cast in this alloy, such as parts of cash registers, typewriters, adding machines, and cooking utensils; pistons for gasoline motors are now produced of this alloy by die-casting.

Pack (302) describes an aluminium-copper alloy which is being commercially die-cast under pressure. The chief commercial difficulty with the die-casting of aluminium is the cracking or heat-checking of the iron or steel molds used; cracks appear in the mold after about 2,000 castings have been made in it.

Composition and properties of casting alloys. The physical properties of light casting alloys with which one is concerned are the tensile properties and the resistance to alternating stresses. The tensile properties of commercial alloys are of course well known; practically no data on the resistance to alternating stresses of these alloys are published although such data are of the utmost importance in view of the use of such castings for machine parts subject to vibration such as motor crank cases.

Some confusion exists with respect to the description of tensile properties; in this country a test specimen cast to size in green sand is usually used to determine these properties; this is usually 0.5 in. in diameter over the reduced section. In Great Britain a specimen cast to size in a chill is often used. Experience has shown that the tensile strength of chill test castings of light alloys will usually average from 3000 to 5000 lb. per sq. in. higher than for sand cast ones. This should always be borne in mind in comparing tests of these alloys.

Not only is the tensile strength of chill castings higher than that of sand castings, but also the elongation. In general any variation of casting condition which increases the tensile strength of a casting alloy increases also its ductility (elongation), and a double gain of hardness and toughness is thereby obtained.

Satisfactory results are obtained either on a cast-to-size test coupon, poured horizontally in sand with gate and riser, or with the Webbert type of cast-to-size coupon, cast in core sand and fed along its whole length by a gate and pouring head. The Naval Gun Factory (Washington) uses the latter form with a gate, $\frac{1}{2}$ in. thick.

(1) "No. 12 alloy" (92 per cent aluminium, 8 per cent copper).

Melting range: 637 to 540 deg. C.

Shrinkage: 0.156 in. per foot.

Probably 95 per cent of all light alloy castings made in this country are of this alloy, probably the best known one to the trade. It is easily handled in the foundry, and does not suffer from hot shortness to the same degree that some of the other alloys do. This alloy can be depended on to give the following tensile properties when properly cast:

Tensile strength	18,000 lb. per sq. in.
Elongation in 2 in.	1.5 per cent
Specific gravity	2.89

If the alloy is overheated or poured too hot, the tensile strength may be as low as 15,000 lb. per sq.in.; on the other hand with skillful handling in the foundry a greater hardness may be obtained, as high as tensile strengths of from 20,000 to 24,000 lb. per sq.in.

Jeffries' finds that this alloy when properly cast to give from 20,000 to 24,000 lb. per sq.in. tensile strength, will withstand 1,000,000 alternations of stress between 0 and 12,000 lb. per sq.in. tension without failure. The alloy is not as strong in impact test as No. 31 (see (3) below).

Broniewski (377) finds the electrical resistance of an alloy of this approximate composition to be 5.60 microhm-cm.

(2) Copper alloys containing from 8.5 to 14 per cent copper:

Melting range: 630—540 deg. C. (depending on copper content).

Shrinkage: 0.156 in. per foot.

These alloys are used for castings which are to be subjected to high temperatures such as manifolds, pistons, and also for castings to withstand pressure such as for pumps, etc.

The 8.5 to 11 per cent alloy is generally used for pistons and the 11 to 14 per cent alloy used for pressure castings.

These alloys will ordinarily give the following physical properties:

Tensile strength	18,000 to 19,000 lb. per sq. in.
Elongation in 2 in.	Usually less than 1 per cent.
Density { 8.5—11 per cent	2.95
{ 11—14 per cent	3.00

Certain of the Lynite casting alloys manufactured by The Aluminum Castings Company are almost identical with the above Nos. 1 and 2. The composition and physical

properties of the Lynite alloys as guaranteed by the company are as follows:

Lynite No. 146—for general castings, such as propellers, crank cases, etc.

Copper	7.0—8.5 per cent.
Other elements	Not over 1.7 per cent.
Aluminium	Balance.
Density	Not over 2.89.

Sand cast	
Tensile strength	24,000—28,000 lb. per sq. in.
Elongation in 2 in.	1.4 to 4.0 per cent.

Die cast	
Tensile strength	About 28,000 lb. per sq. in.
Elongation in 2 in.	

Lynite No. 122—for casting for use at higher temperatures: pistons, etc.

Copper	9.25 to 10.75 per cent.
Other elements	Not over 2.0 per cent.
Aluminium	Balance.
Density	Not over 2.95.

Die cast	
Tensile strength	About 28,000 lb. per sq. in.

Lynite No. 109—for pressure castings.

Copper	11.5 to 13.5 per cent.
Other elements	Not over 1.7 per cent.
Aluminium	Balance.
Density	Not over 2.97.

Sand cast	
Tensile strength	19,000 lb. per sq. in.
Elongation	

(3) "No. 31" (zinc 15 per cent, copper 3 per cent, aluminium 82 per cent).

Melting range: 625 to 440 deg. C.

Shrinkage: 0.156 in. per foot.

This alloy has hitherto been used more extensively abroad, particularly in Great Britain than here in this country. Its higher tensile strength as compared with No. 12 has not in this country outweighed the doubt in the minds of many of its performance and its freedom from deterioration upon aging. This illusion has now, it is believed, been largely dispelled and there seems no reason why the alloy should not become more popular.

This alloy can usually be depended on to give the following properties:

Tensile strength	22,000—25,000 lb. per sq. in.
Elongation in 2 in.	0.5 to 3.0 per cent.
Specific gravity	3.0

When poured properly and at a low temperature a tensile strength of 30,000 lb. per sq.in. may be obtained with this alloy.

This alloy has a low resistance to alternating stresses, but is tougher in impact than the copper alloys (Nos. 1 and 2)¹.

(4) Magnalium, 50 per cent alloy.

Melting range: 625 to 450 deg. C.

Shrinkage: 0.187 in. per foot.

This alloy is one of the earliest commercial alloys. The term originally connoting an alloy of aluminium containing from 5 to 30 per cent of magnesium, now covers a variety of commercial alloys containing magnesium and also small quantities of copper and nickel.

A "magnalium" used at one time by the Westinghouse Electric & Manufacturing Company (395) contains 5 per cent of magnesium. This alloy may be depended on to give the following tensile properties²:

Tensile strength	20,000 lb. per sq. in.
Elongation in 2 in.	0.5—2.0 per cent.
Specific gravity	2.63

¹Communication from The Aluminum Casting Co. through Prof. Z. Jeffries.

²Communication from Prof. Jeffries of The Aluminum Castings Co.

¹Private communication from The Aluminum Castings Company, through Prof. Z. Jeffries.

²Communication from M. J. I. Jones of the Westinghouse Co.

With care a tensile strength of 25,000 lb. per sq.in. and an elongation of 5 per cent may be obtained.

(5) Alloy containing 35 per cent zinc.

Melting range: 585 to 440 deg. C.

Shrinkage: 0.156 in. per foot.

This alloy is much used for general castings in which strength is not a principal consideration. It casts well, but has little or no ductility. Its tensile strength is usually about 35,000 lb. per sq.in. as cast. Its specific gravity is 3.32.

(6) Alloy containing 1 to 2 per cent of copper and 1 per cent of manganese.

Melting range: 649 to 529 deg. C.

Shrinkage: 0.187 in. per foot.

This alloy is described by McKinney (453) and is suitable both for casting and for forging. Cupromanganese may be used in preparing it, and it is not apparently a difficult alloy to handle in the foundry. This alloy will usually have the following tensile properties or better:

Tensile strength 18,000 lb. per sq. in.
Elongation in 2 in. 8 per cent.
Specific gravity about 2.80.

With care this alloy may be cast to have a tensile strength of 21,000 lb. per sq.in. with an elongation in 2 in. of 16 per cent. This alloy is used almost entirely by the Naval Gun Factory, Washington, D. C.

ROLLING AND FORGING

Alloys for rolling or forging generally contain smaller percentages of the "hardener" metal than those for casting. Except when zinc is used, the total content of added metal to such alloys rarely exceeds 6 per cent and is usually less. The rolling or forging of these alloys is usually carried out in a manner quite similar to the practice followed for aluminium, although the temperatures used for hot breaking down are often somewhat lower owing to the lower melting point of the alloy, and it is usually annealed during cold rolling.

(1) Aluminium-manganese alloy.

An alloy (No. 3-S) containing manganese is rolled by the Aluminum Co. of America particularly into sheet, for use wherever a stiffer material than aluminium is desired. This alloy is superior to most other alloys of aluminium in its resistance to corrosion. The tensile properties of this alloy in sheet form average:

	Hard	Soft
Tensile strength in lb. per sq. in.	30,000	15,000
Elongation in 2 in., per cent.	2	25

(2) Alloy containing 1 to 2 per cent copper and 1 per cent manganese.

This alloy, used at the Naval Gun Factory (453), for small forgings may be readily forged at a temperature of about 625 deg. C. If finished at a temperature of about 250 deg. C. the forging is much harder. Forgings of this alloy give the following tensile properties:

	Finished cold	Finished hot
Tensile strength in lb. per sq. in.	27,800	21,100
Yield point in lb. per sq. in.	27,800 (?)	12,200
Elongation in 2 in., per cent.	12	27
Reduction of area, per cent.	47	49

The alloy is said to be quite satisfactorily resistant to corrosion in sea air.

(3) A forging alloy used by the Aluminum Castings Company has the following chemical composition:

Copper, 2.75 to 3.25 per cent; aluminium, the balance. It will yield the following tensile properties:

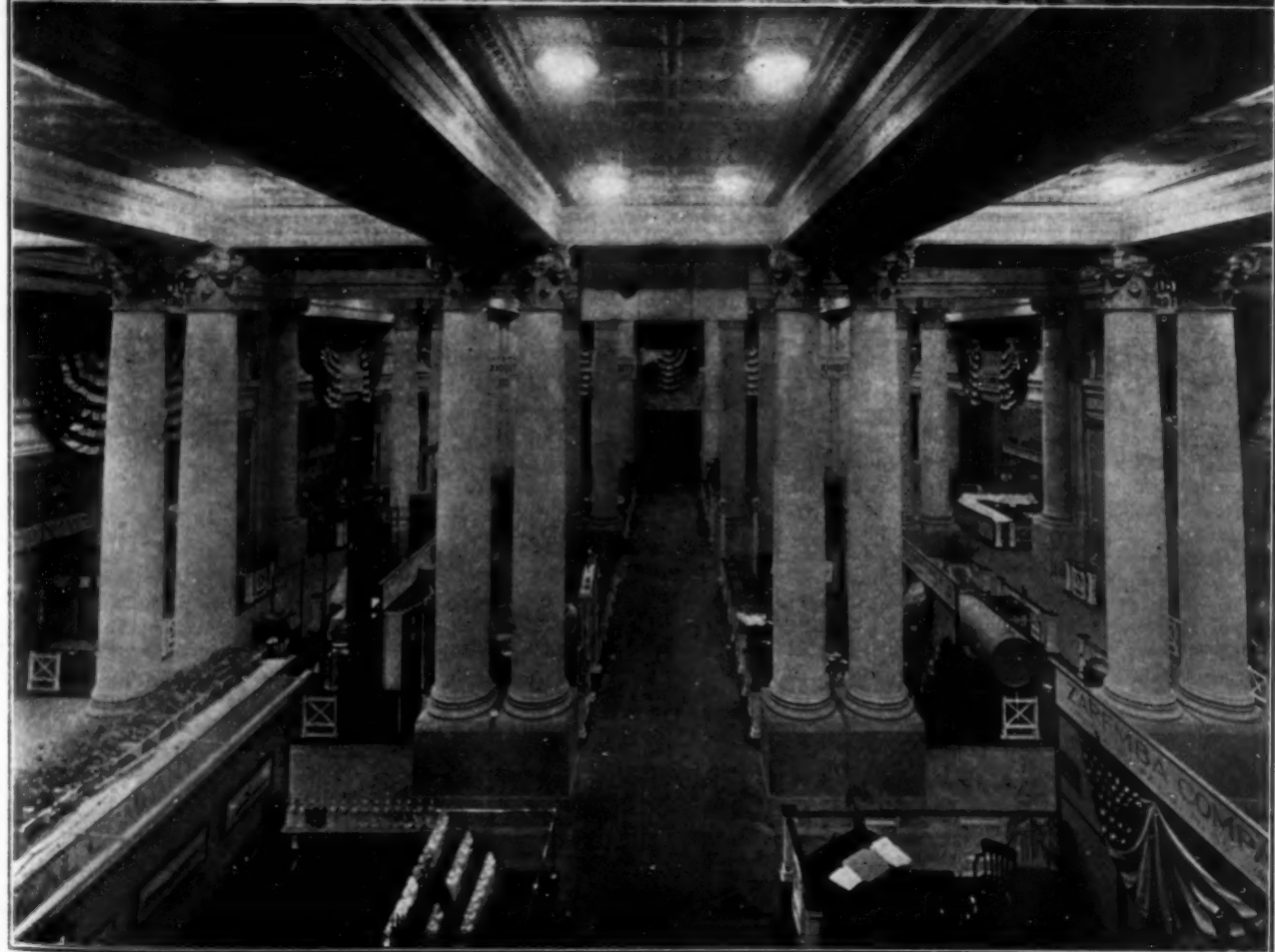
Tensile strength 24,000 lb. per sq. in.
Yield point 16,000 to 17,000 lb. per sq. in.
Elongation in 2 in. not under 3.5 per cent.

(4) A machining rod alloy (No. 15-S) containing zinc and copper is produced by the Aluminum Co. of America. The average properties are:

Tensile strength 42,000 lb. per sq. in.
Elongation in 2 in. 10 per cent.

(5) The Aluminum Co. of America recommends an alloy of from 10 to 15 per cent zinc for general forgings. This is said to flow well in the dies, and has satisfactory physical properties.

Iron, Carbon and Phosphorus.—DR. J. E. STEAD added another paper to his contributions on the behavior of phosphorus in iron and steel at the annual meeting of the Iron and Steel Institute held in London, May, 1918, in which he recounted a series of experiments showing qualitatively that the temperature where the phosphide of iron (Fe_3P) passed into solid solution in ferrite varied with the amount present, thus conforming to the expected behavior of a binary system such as salt-water. In 1890 he noted that slow cooling from 1200 deg. C. of a 12-point steel containing 2 per cent phosphorus gave free phosphide along ferrite cleavages. Experimenting now with a decarburized blast furnace "bear" containing free phosphide envelopes and inclusions in ferrite crystals containing possibly 0.5 per cent P in solid solution he found that the free phosphide entered the solution at some temperature between 800 and 850 deg. C., and was nearly complete after 15 minutes at 960 deg. Diffusion is very slow, and on reheating at lower temperatures the phosphide re-crystallizes around the traces of the original crystals. Free crystals of iron-nickel phosphide (rhabdite) contained in a meteorite commenced to dissolve after 12 hours at 600 deg. C. Alloys containing 2 per cent phosphorous made by the thermit process showed solid solutions after 6 hours at 1000 deg., but developed new crystals freely after 6 hours at 800 deg. C. A rolled bar which had previously been phosphoized at a white heat was bedded in mill scale, and one end heated to 961 deg. C. for 60 hours. Phosphide crystals appeared in that portion which had been held at a temperature of 660 up to 900 deg., increasing in size with the temperature. In absolute amount they were maximum at 800 to 850 deg. C., while at 961 deg. a homogeneous solid solution existed. No eutectic films were shown, and no phosphide crystals were present in decarburized eutectoid zones, since phosphide and carbide are mutually repellant. Pearlitic areas in phosphoretic steel castings and the ferrite immediately adjacent are nearly phosphorous-free, while the body of the ferrite crystals contain the phosphide in solid solution. In the cementation of phosphoretic steel, the migrating carbon drives the phosphorus before it, eventually making localized spots of concentrated iron—iron phosphide solid solution. The specific amount of carbon absorbed therefore varies with the phosphorus content. At 1200 to 1300 deg. C. the concentrated $\text{Fe-Fe}_3\text{P}$ solution melts at the center of the ferrite crystal in a globule, and on being further heated, eventually liquates as a ternary Fe-P-C eutectic.



Personal

MR. G. A. ARMSTRONG has severed his connections with E. J. Loomis & Co., Philadelphia, Pa., to accept a position as chemical engineer in charge of intermediates with the Central Dyestuff and Chemical Co., Newark, N. J.

MR. W. J. ARMSTRONG, manager of the crushing and pulverizing sales department of the Jeffrey Manufacturing Company, Columbus, Ohio has recently received an appointment as captain in the United States Army and assigned to the Ordnance Department in Washington, D. C.

MR. ZENO D. BARNES is now connected with the general operating department of The Aluminum Castings Company, with headquarters in Cleveland. For the past three years Mr. Barnes was non-ferrous metallurgist for the Westinghouse Air Brake Co.

PROFESSOR GEORGE BORROWMAN has taken up research work for the Niagara Alkali Company under the direction of Dr. John E. Teeple, 50 East 41st Street, New York. He was formerly at the University of Nebraska.

MR. CYRIL B. CLARK of the Research Department of the General Chemical Company, New York, has been detailed on some special work for this company's Bay Point Works near San Francisco. Mr. Clark expects to return to New York in four months when the work is to be completed.

MR. JOHN A. COYE has accepted the position of assistant chemist with the General Chemical Company's Laurel Hill works.

MR. CONRAD DRESSLER has been awarded the John Scott medal by the Franklin Institute of Philadelphia in recognition of his contribution to the advancement of the science of firing (furnaces for annealing, etc.).

CAPTAIN J. J. GAILLARD has assumed the position of district engineer in charge of the Atlanta office, Portland Cement Association, succeeding Mr. W. Jess Brown who resigned to accept a commission as captain in the Ordnance Department, U. S. Army. Captain Gaillard joined the forces of the Portland Cement Association January 1, 1918, and since that time has been doing general promotion and inspection work in the district covered by the Atlanta office of the association.

MR. CHARLES HENROTIN of Haileybury, Ont., is operating a fluorspar property near Madoc, Ont., and is shipping this product to the United States.

MR. C. A. NASH has accepted the position of research chemist with the Cutler-Hammer Manufacturing Company, of Milwaukee. Mr. Nash was formerly associate in chemistry at the University of Chicago.

MR. L. J. PLETCHER has withdrawn from teaching to enter the service of the Texas Refinery, Port Arthur, Texas as research chemist.

DR. J. H. RANSOM has been elected professor of chemistry and director of the chemical laboratories in Vanderbilt University, Nashville, Tenn. Dr. Ransom has been at Purdue University for the last eighteen years.

MR. CHARLES F. ROTH, one of the managers of the National Exposition of Chemical Industries and Secretary of the New York Section of the American Chemical Society is in the Personnel Section of the Chemical Warfare Service where he has charge of the census of chemists which is being taken by the War Department.

MR. L. DUANE SIMPKINS has accepted the position as chief metallurgical chemist and metallographer for the Peters Cartridge Co., Kings Mills, Ohio.

to get his supply, but his status in war production, that directs the allocation of the metals.

Aluminum:—The Government prices on ingots 98 to 99 per cent Al are \$660 a ton f.o.b. plant in 50-ton lots; \$662 down to 15-ton lots; and \$666 down to 1-ton lots, which prices will continue the remainder of the year. Prices per pound for small lots vary from 40 to 45c.; sheet aluminium, 18ga. and heavier, 42c.; powdered aluminium, 100 mesh, 70c.

Antimony:—The recent rise in antimony was but temporary, the price now being 14 to 14½c. for duty paid spot delivery.

Chrome:—Western production is now in slight excess of demand. The nominal quotation for 40 per cent ore is \$1.40 per unit, while 50 per cent ore is bringing \$1.70.

Copper:—The price of \$520 per ton for car load lots and 27.3c. per pound for small quantities is permanently fixed.

Copper sheets, hot rolled.....	lb.	\$0.36	—\$0.37½
Copper sheets, cold rolled.....	lb.	.37	— .38½
Copper bottoms.....	lb.	.44	— .45½
Copper rods.....	lb.	.36	— .37
Copper wire.....	lb.	.29½	— .30
High brass wire.....	lb.	.28½	— .29½
High brass sheets.....	lb.	.28½	— .29½
High brass rods.....	lb.	.26½	— .28½
Low brass wire.....	lb.	.32½	— .34½
Low brass sheets.....	lb.	.32½	— .34½
Low brass rods.....	lb.	.33½	— .35½
Brass tubing.....	lb.	.37	— .39
Brazed bronze tubing.....	lb.	.42½	— .44½
Seamless copper tubing.....	lb.	.41	— .43
Seamless bronze tubing.....	lb.	.45	— .46
Seamless brass tubing.....	lb.	.37½	— .39½
Bronze (gold) powder.....	lb.	1.00	— 1.75

Lead:—The lead market is limited by selling restrictions. Producers must sell at a uniform and pre-arranged price. In car load lots at East St. Louis, the price is \$155 per ton. In New York, all speculative and traders' lead has disappeared. The Lead Committee apportions lead at 8.05c. to legitimate consumers.

Manganese:—The scale prices on page 629 of CHEMICAL & METALLURGICAL ENGINEERING, June 15, prevail; the highest price per unit being \$1.35.

Zinc:—Spelter continues to advance. East St. Louis is selling at \$183 to \$185 per ton in car lots; New York quotations are from 9.4 to 9.5c. per pound; sheet zinc 15c. and zinc dust (300 mesh) 16c. per pound in 1600-lb. casts.

Silver:—The Government price of \$1.01½ is hoped to promote production.

Tin:—The market is awaiting further development on the inter-Allied conference on tin. The War Industries Board will soon announce regulation prices and control the distribution of our 80,000-ton allocation. Tin is priced at 80c. per pound nominally.

Tungsten:—The western producers of scheelite are reluctant in offering at \$25.50 per unit. High grade wolframite is bringing \$25. Off-grade ores vary from \$20 to \$24.

OTHER METALS

Bismuth.....	lb.	\$3.50	—\$3.65
Cadmium.....	lb.	1.50	— .
Cobalt.....	lb.	2.50	— 3.50
Magnesium.....	lb.	1.75	— 2.00
Mercury.....	lb.	125.00	— .
Nickel.....	lb.	1.95	— .
Iridium.....	oz.	175.00	— .
Palladium.....	oz.	135.00	— .
Platinum.....	oz.	105.00	— .

The Iron and Steel Market

On September 23 the War Industries Board began holding a series of meetings with representatives of different branches of the iron and steel trade to consider two things: (1) Possibilities of increasing production of steel; (2) possibilities of conserving steel by reducing the amount converted into various finished products. The board had previously called upon all war activities to pare their estimates of steel required as much as possible. This work is dictated by the fact that the estimated requirements for the half year still total 23,000,000 net tons while the production can hardly materially exceed 19,000,000 tons. One finished steel product is not considered, except in a general way, by the War Industries Board, that being tin plate, which is under the jurisdiction of the Food Administration. Early last May the production and shipment of tin plate

Current Market Reports

The Non-Ferrous Metal Market

Tuesday, Sept. 25.—The metal markets are quiet, distribution being under Government control; varying monetary offerings can exert no influence on the market. It is no longer a question of what a certain manufacturer will give

was required to be confined to the filling of Government orders and the requirements of the perishable foods. Early in September, with the end of the canning season near at hand, an order was issued restricting by 30 per cent the manufacture of tin plate during the fourth quarter. While it had been expected that at the end of the canning season tin plate would be allowed to go to the non-perishable foods, and perhaps also to other lines of consumption, the Food Administration made no order, but undertook to meet, in order, representatives of the packers of the various non-perishable foods, for the purpose of limiting their consumption of tin plate. At this writing the tin plate trade is in expectation of receiving orders to cut its production by still more than the 30 per cent originally prescribed.

The outstanding feature of the present situation as to steel supplies is that all the news relates to efforts to conserve steel by reducing the amount consumed by various finishing operations. Excepting the one item of rails, there is no important activity which is specifically designated as requiring an increased supply of steel. From one viewpoint, the strenuous efforts being made to conserve steel would suggest that there is a great shortage, but from another viewpoint there is the opposite suggestion, that by conservation along various lines a considerable tonnage of steel may be released while there is no well defined additional use to which the steel would be put, excepting in the one case of rails. As to rails, the Railroad Administration has been calling for 60,000 tons a week and has been receiving 40,000 tons, which, in 85-pound rails, is enough to lay 300 miles of track per week, and there is a question whether labor can be provided for any greater activity than this. The American Expeditionary Force has been calling for large tonnages of rails, and it is desired to increase the rate of shipment, though by what weekly tonnage is not known. If there is a deficiency in rails it certainly does not amount to any large fraction of the much talked-of 4,000,000 ton deficiency in steel in general.

Thus the aspect of the great question, whether or not there is enough steel, continues to change. Late in 1917 many steel producers expected steel to become plentiful within a few months, through the peace consumption decreasing. The sharp curtailment in production during the winter caused a postponement of the time at which steel was expected to become plentiful, a not uncommon view being that steel might be plentiful in April. Just at the beginning of that month the Director of Steel Supply began a campaign to convince the steel makers that more war steel was required and during the next three months the distribution of the entire output of steel was taken over by the War Industries Board. Eventually the steel industry was convinced that direct war needs and essential commercial requirements would absorb the entire output, while the shortage of several million tons the War Industries Board insisted would occur in the second half of the year was considered quite seriously. After the lapse of three months of the half year, however, with no evidence of any large deficiency accumulated, some doubt is beginning to be felt.

OPERATING CONDITIONS

Shortage of labor is felt more or less throughout the iron and steel industry, but no such shortage as to interfere seriously with production. The bottle neck, so far as steel output is concerned, is the supply of pig iron. More steel could be made, with the same supply of labor, if there were more pig iron. The present supply of pig iron, however, would be adequate if there were at the same time a normal supply of scrap, but war time conditions cause the outcome of scrap to be much less than normal.

The supply of pig iron, again, is much below what would be expected of the blast furnaces in operation if they were given normal operating conditions. Since April 1 the rate of pig iron production has been between 40,000,000 and 41,000,000 tons a year. Various comparisons, of the output in 1916, with allowance for new furnaces completed since the beginning of that year, and of the number of furnaces lately in blast, indicate that under 1916 conditions the output of pig iron should be at the rate of at least 43,000,000

tons a year. The cause of the discrepancy has been earnestly sought and the common disposition among furnacemen is to attribute the discrepancy chiefly to the quality of coke available. This led the Fuel Administration several weeks ago to undertake a system of coke inspection, while at the same time, by speeches and otherwise, the miners are urged to mine cleaner coal and the operators to pay more attention to coke quality in general. One coke operator has been required to refund \$80,000 to customers, and another \$75,000, on account of inferior coke furnished in recent months, and in future coke not up to standard is to be penalized in price \$1 a ton. Analysis of the Geological Survey's weekly reports of coke production indicates that the quantity of coke being produced is sufficient. The rate is 61,000,000 net tons a year, about 47 per cent by-product and 53 per cent bee-hive, with the by-product increasing nearly every week.

Pig iron production increased somewhat during September and still better output is expected in October, traditionally the best month of the year for furnace operations. Late in September the Brier Hill Steel Company, Youngstown, O., completed a new furnace, and if the report is correct that the furnace cost \$3,000,000 a new record has certainly been set in blast furnace construction. Unless after the war there is to be no reversion at all to pre-war conditions, a very heavy amortization charge is imperative against such new construction.

FOURTH QUARTER PRICES

In many branches of the iron and steel trade claims were made that in the adjustment of prices for the fourth quarter various advances should be made. These claims were formulated in rather elaborate manner, with many meetings of the interests involved. The outcome was an advance of 25 cents a ton in Lake Superior iron ore, intended to cover wage advances, as the 45-cent advance effective July 1 was absorbed almost entirely by the freight rate advance, and an intricate advance in pig-iron prices. Unfinished and finished steel prices were not altered.

The price of each grade of pig iron had been uniformly f.o.b. furnace. All basis prices were advanced \$1 a ton, except that for Bessemer iron. Tennessee and Virginia furnaces were removed from the furnace basis and placed on a Birmingham basis. Furnaces north of the Potomac River and east of the Allegheny Mountains were placed on a Pittsburgh basis. Thus in the case of foundry iron 1.75 to 2.25 per cent silicon, the Tennessee furnace formerly sold at a delivered price of \$33 plus freight from furnace to delivery point, but will now sell at \$34 plus freight from Birmingham to delivery point, the realized price being increased by \$1 plus the freight advantage. As further illustrative of the new price schedule, the New England consumer formerly patronized the furnace making the lowest delivered price, Buffalo, eastern Pennsylvania, Virginia and Alabama being more or less in competition. Now the prices made by the four districts will show wide variations, Buffalo selling at \$34 plus freight from Buffalo, eastern Pennsylvania at \$34 plus freight from Pittsburgh and Virginia and Alabama at \$34 plus freight from Birmingham. The consumer will choose when he can but will have to take iron from the furnace that can supply it. The arrangement is logical only in that it takes account that the costs have increased more in some districts than in others.

The Chemical Market

COAL TAR PRODUCTS:—Active trading has been more pronounced for the past two weeks in the majority of intermediates. However, activity in some of the items was curtailed by the scant supply of certain crudes and other unfavorable conditions that are prevailing. Prices on the whole are maintained at firm levels while some of the products have a strong upward tendency. Of these are benzol and phenol, which have attained a firmer position.

Benzol:—The actual trading position of this item has been rather erratic during the past two weeks, the latter period of which a firm situation developed with a fractional increase in price in tank car material and also that in drums. Stocks, however, are in liberal supply, but the demand is becoming more pronounced.

Phenol:—The market for this item has also developed a firmer tone. Its position, however, has been seemingly brought about by extensive purchasing for export purposes, while local requirements are reasonably active, in so far as the steady routine of business, which is generally passing. The firmness therefore having caused an increase in prices.

Paranitraniline:—The interest is persistent and the scarcity of stocks, which have been prevailing for some time, is at present offering no encouragement. The scattered spot lots which appear on the market are held at a variation of prices that trading is only as pressing requirements demand.

Para Amidophenol:—The material is neither in pronounced demand nor supply. Prices continue at the same firm levels.

Paranitrotoluol:—Factors in this line are all sold up and the occasional lots which appear on the market are absorbed readily. Prices, however, remain at firm levels.

Diethylaniline:—Most producers are sold ahead for a fair period and supplies that are available are held mainly in second hands. The demand is steady and prices are quotably unchanged.

Benzoate of Soda:—A strengthening situation has become in evidence during the recent period with an advance in prices. It is the prevailing impression a higher market level will be seen, in view of the strong buying interest, more noticeable, however, for the acid material.

Aniline Oil:—The volume of business passing is apparently having no material effect on the quantity of stocks, though no unusual surplus is reported on hand. Prices are firm though, in some directions, fractionally easier.

H-Acid:—Spot lots are difficult to locate and producers are generally out of the market. Therefore prices are quotably nominal.

Sulphuric Acid:—Production continues to be confined to a few dealers. Prices are firm but the market is rather quiet, and supplies are in accordance with the consuming requirements.

Toluol:—The position of this material is no easier. It may be stated that only small quantities of the product are released by the Government, which has the entire situation in hand.

Phthalic Anhydride:—A strong demand with only limited stocks is the position of this item. Prices are without quotable change in view of the stringent situation.

Metatoluylenediamine:—The production of this material is not liberal, due to the toluol situation and, while the demand is only general, stocks are scarce. Quotations heard are still at firm levels.

HEAVY CHEMICALS:—The items that fall under this classification have in a number of instances commanded considerable interest in the past two weeks. Though many of the products which are in steady demand through routine channels have otherwise not been noticeably active and subject to no material change. Prices for the latter mentioned have undergone no particular fluctuations, though in some directions slightly lower levels were in evidence. Caustic soda, however, and its allied product, soda ash, were the prominent features of the market. Each of the items reaching levels, during the close, that were considered unusually high with no easement in sight and considerable speculation as to the futures. The supply of all acids continues scarce.

Soda Ash:—The volume of business in New York during the past two weeks has been exceedingly active. It may be safely stated that each day developed a more strengthening position, with prices increasing accordingly. The firmness coincident with the diminishing stocks made it appear as though the market was destined to unheard-of levels. Single bags were sold at from \$2.55 to \$2.60 warehouse, barrels from local store were generally held at \$3.15 minimum, and up to \$3.25. Double bags rolling to the coast were quoted at \$3.15 to \$3.20 and a car of dense ash rolling to the coast was held at \$5.15 coast.

Sodium Cyanide:—The item is more or less neglected in the open market and trading is mainly through routine channels. In the resale market spot lots were offered at from 31c. to 34c.

Caustic Soda:—The item during most of the past week has been exceedingly strong and to such an extent that stocks are diminishing in consequence of the pressing demand. On the spot prices ranged from \$4.30 to \$4.80, though the sale of the latter was generally regarded as high with the opinion that \$4.30 to \$4.35 represented the true market price for spot material. However, at these quotations offerings were scarce and material was held at such figures that large consumers displayed hesitancy in closing. Figures for over the balance of the year were \$4.35 f.o.b. works and for immediate shipment offerings were made at from \$4.35 to \$4.40 works, according to the seller.

Pernanganese of Potash:—Production of this material under ordinary conditions has apparently been sufficient to take care of the consumption demand. But circumstances have created a sudden change during the latter end of the past week when a strengthening situation developed. Therefore in the open market sales have been reported at higher levels than were noted for some time and at the closing the U. S. P. material was generally held at from \$1.90 to \$2.00 with active trading at these figures, though in some directions the prices could be shaded. The technical product in sympathy with the U. S. P. has attained a firmer position and prices range from \$1.60 to \$1.75 according to quality and some of the higher grades are held at \$1.80.

Bichromate of Soda:—No unusual interest is evidenced for this material and it is difficult to determine its position in the market. Stocks are in liberal quantities and the entire situation is seemingly in favor of the buyer. Some low quotations are heard and sales are passing from 23c. to 24c.

Bleaching Powder:—Prices for this commodity have advanced in leaps and bounds during the interval and authorities in this line predict a 6c. market and perhaps higher prices in the near future. There seems to be a question at present writing, as to what the actual market level is. October-November-December were available at \$4.50 subject to government control, or requisition and some traders would not shade 4¼c. for November or December. A report from the American Consulate-General, London, September 16, states:—

The Ministry of Munitions notifies that from September 16 no person shall produce or manufacture chlorine or chlorine compounds in quantities exceeding one-tenth per month under license, nor shall more than 10 be employed by manufacturer for purposes of other manufacturers, trades, and business except under license. From September 16 no person shall sell or offer for sale or purchase any liquid chlorine or bleaching powder exceeding following maximum prices: Liquid chlorine 6d, per pound, bleaching powder £15 per ton. However, maximum prices do not apply to goods for export from United Kingdom or sales of less than 56 pound weight.

Carbon Bisulphide:—In the situation of this material there is little change noted and trading is reasonably active. Prices remain firm in most instances at from 8 to 9c. f.o.b. works and 7¼c. f.o.b. works, contract basis.

Carbonate of Magnesia:—The market has been barely steady with sellers offering various quotations and on the whole the item has been neglected by the majority of users. The technical is held at from 15 to 16c. ex store in bags of 100 lb. for less than carload lots and in larger quantities 14 to 15c. f.o.b. mills is the general asking price.

Magnesia, Calcined:—The high grade technical which is mainly in demand by the rubber making trade is an active item and is offered at 65 to 75c. medium grades, at 40 to 50c. and the heavy at from 9½ to 12c. Interest in the item is nothing of consequence, other than the regular routine of business.

Bicarbonate of Soda:—The present production of this material is reported to be insufficient to take care of all the business now placed. However, frequent lots appear on the market and two cars of this material for October-November delivery were quoted at \$3.10. The price is considered low as efforts to cover at \$3.25 were reported as unsuccessful. The market for prompt shipment is quoted by factors to be \$3.40 to \$3.50.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, SEPT. 24, 1918

Acetic anhydride	lb.	1.60	1.85
Acetone	lb.	25 1/2	25 1/2
Acetic, 28 per cent	cwt.	5.95	6.11
Acetic, 56 per cent	cwt.	10.76	10.87
Acetic, glacial, 99 1/2 per cent, carboys	cwt.	19.00	19.20
Boric, crystals	lb.	13 1/2	13
Citric, crystals	lb.	82	
Hydrochloric, C. P.	lb.	08	08 1/2
Hydrofluoric, 50 per cent in barrels	lb.	13	10
Lactic, 44 per cent	lb.	06	07
Lactic, 22 per cent	lb.	6.90	7.40
Molybdic	lb.		Nominal
Nitric, 36 deg.	lb.	08 1/2	10
Nitric, 42 deg.	lb.	08 1/2	10
Oxalic, crystals	lb.	42	44
Phosphoric, 47-50 per cent paste	lb.	07 1/2	10
Phosphoric, ref. 50 per cent	lb.	35	40
Picric	lb.	75	85
Pyrogallol, resublimed	lb.	1.25	3.50
Sulphuric, 60 deg.	ton	18.00	
Sulphuric, 66 deg.	ton	28.00	
Sulphuric, oleum (Fuming), tank cars	ton	60.00	65.00
Tannic, U. S. P., bulk	lb.	1.40	1.50
Tartaric, crystals	lb.	86	95
Tungstic, per lb. of W	lb.	1.70	1.75
Alcohol, sugar cane, 188 proof	gal.	4.91	
Alcohol, wood, 95 per cent	gal.	91 1/2	92
Alcohol, denatured, 180 proof	gal.	68	69
Alum, ammonia lump	lb.	06	06 1/2
Alum, chrome ammonium	lb.	18	19
Alum, chrome potassium	lb.	21	22
Alum, chrome sodium	lb.	12 1/2	13
Alum, potash lump	lb.	07 1/2	10
Aluminum sulphate, technical	lb.	02	02 1/2
Aluminum sulphate, iron free	lb.	03 1/2	04
Ammonia aqua, 26 deg., carboys	lb.	08 1/2	09
Ammonia, anhydrous	lb.	12	13
Ammonium carbonate	lb.	(Fixed Price)	15
Ammonium nitrate	lb.	07 1/2	08
Ammonium sulphate domestic	gal.	5.10	5.15
Amyl acetate	gal.	09 1/2	13
Arsonic, white	lb.	61	70
Barium carbonate, 99 per cent	ton	80.00	90.00
Barium carbonate, 97-98 per cent	ton	65.00	67.00
Barium chloride	ton	70.00	80.00
Barium sulphate (Blanc Fixe, Dry)	lb.	04 1/2	05
Barium nitrate	lb.	12	14
Barium peroxide, basis 70 per cent	lb.	30	32
Bleaching powder, 35 per cent chlorine	lb.	05	05 1/2
Borax, crystals, anhydrous	lb.	08 1/2	08 1/2
Bromine, crude	ton	65.00	70.00
Bromine, technical	lb.	75	
Calcium acetate, crude	lb.	04	05
Calcium carbide	lb.		
Calcium chloride, 70-75 per cent, fused, lump	ton	22.00	24.00
Calcium peroxide	lb.	1.50	1.70
Calcium phosphate	lb.	22	23
Calcium sulphate-98-99 per cent	lb.	09	09 1/2
Carbon bisulphide	lb.	08	09
Carbon tetrachloride, drums	lb.	60	70
Carbonyl chloride (phosgene)	lb.	1.10	1.50
Cassite potash, 85-97 per cent	lb.	63	77 1/2
Cassite soda, 76 per cent	100	4.40	4.45
Chlorine, liquid (Government Purchase)	lb.	(Fixed Price)	07 1/2
Coal oil	lb.	1.60	1.65
Copper	lb.	02 1/2	02 1/2
Copper carbonate	lb.	30	31
Copper cyanide	lb.	75	78
Copper sulphate, 99 per cent, large crystals	lb.	09 1/2	09 1/2
Cream of tartar, crystals	lb.	76	80
Eosin salt, basic, U. S. P.	100	3.62 1/2	3.90
Formaldehyde, 40 per cent	lb.	16 1/2	
Glauber's salt	lb.	02 1/2	03
Glycerine, bulk, C. P.	lb.	63	65
Iodine, resublimed	lb.	4.25	4.30
Iron oxide	lb.	13	15
Lead acetate, white crystals	lb.	17	17 1/2
Lead arsenate (Paste)	lb.	15	18
Lead nitrate	lb.	Nominal	
Litharge, American	lb.	17	14
Lithium carbonate	lb.	1.50	2.05
Magnesium carbonate, technical	lb.	16	17
Nickel salt, single	lb.	14	15
Nickel salt, double	lb.	12	13
Phosgene, (see Carbonyl chloride)	lb.	1.10	1.50
Phosphorus, red	lb.	1.00	1.15
Phosphorus, yellow	lb.	1.10	1.20
Potassium bichromate	lb.	45	46
Potassium bromide granular	lb.	1.25	1.25
Potassium carbonate calcined, 85-90 per cent	lb.	38	40
Potassium chlorate, crystals	lb.	40	70
Potassium cyanide, 98-99 per cent	lb.	3.75	3.80
Potassium iodide	ton	300.00	350.00
Potassium molybdate 80-85 p. e. basis of 80 p. e.	lb.	27	31
Potassium nitrate	lb.	1.65	1.80
Potassium permanganate U. S. P.	lb.	2.30	2.0
Potassium persulfate, yellow	lb.	1.00	1.10
Potassium sulphate, 90-95 p. e. basis 90 p. e.	ton	Nominal	
Rochelle salts	lb.	47	48
Salammoniac, gray gran	lb.	19	20
Salammoniac, white gran	lb.	1.40	1.55
Salt cake	ton	22.50	25.00
Silver cyanide, based on market price of silver	oz.	63 1/2	64
Silver nitrate	oz.	2.60	
Soda ash, 50 per cent, light, flat (bags)	100	3.75	3.80
Soda ash, 50 per cent, dense, flat	100		
Sodium acetate	lb.	03	04
Sodium bicarbonate, domestic	lb.	23 1/2	24
Sodium bicarbonate, English	lb.	12	14
Sodium bisulphite, powder	lb.	25	25 1/2
Sodium chlorate	lb.	30	35
Sodium cyanide	lb.	17	18
Sodium fluoride, commercial	lb.		

Sodium hyposulphite	lb.	2.80	3.00
Sodium molybdate, per lb. of Mo.	lb.	2.50	
Sodium nitrate, 95 per cent	100	4.12	5.00
Sodium nitrite	lb.	37	38
Sodium peroxide	lb.	35	45
Sodium phosphide	lb.	39	40 1/2
Sodium phosphate, yellow	lb.	39	40
Sodium silicate, liquid (60 deg.)	lb.	02 1/2	03 1/2
Sodium sulphide, 30 per cent, crystals	lb.	06 1/2	07
Sodium sulphide, 60 per cent, fused	100	10	10 1/2
Sodium sulphite	lb.	05 1/2	06
Strontium nitrate	lb.	25	30
Sulphur chloride, drums	lb.	07 1/2	09
Sulphur dioxide, liquid, in cylinders	lb.	15	40
Sulphur, flowers, sublimed	100	4.35	4.50
Sulphur, roll	100	3.70	3.85
Sulphur, crude	ton	65.00	70.00
Tin bichloride, 50 deg.	lb.	28	29
Tin oxide	lb.	Nominal	
Zinc carbonate	lb.	18	20
Zinc chloride	lb.	15	15 1/2
Zinc cyanide	lb.	Nominal	
Zinc dust, 350 mesh	lb.	13 1/2	14
Zinc oxide, American process XX	lb.	12 1/2	14
Zinc sulphate	lb.	04 1/2	06 1/2

Coal Tar Products (Crude)

Benzol, pure, water white	gal.	23	28
Benzol, 90 per cent	gal.	25	
Toluol, in tank cars	gal.	(Fixed Price)	1.50
Toluol, for non-military use, in drums	gal.	(Fixed Price)	1.55
Xylol pure, water white	gal.	45	55
Solvent naphtha, water white	gal.	18	25
Solvent naphtha, crude, heavy	gal.	12	15
Cresote oil, 25 per cent	gal.	45	55
Dip oil, 20 per cent	gal.	30	32
Pitch, various grades	ton	8.00	20.00
Carbolic acid, crude, 95-97 per cent	lb.	1.05	1.10
Carbolic acid, crude, 50 per cent	lb.	60	65
Carbolic acid, crude, 25 per cent	lb.	35	38
Creosol, U. S. P.	lb.	19	20

Intermediates, Etc.

Alpha naphthol, crude	lb.	1.00	1.10
Alpha naphthol, 60 deg.	lb.	1.50	1.60
Alpha naphthylamine	lb.	55	60
Aniline oil, drums extra	lb.	28	30
Aniline salts	lb.	44	45
Anthracene, 80 per cent	lb.	Nominal	
Benzaldehyde (f. f.)	lb.	4.25	4.50
Benzidine, base	lb.	1.75	1.85
Benzidine, sulphate	lb.	1.40	1.45
Benzoin acid U. S. P.	lb.	2.75	2.95
Benzoate of Soda, U. S. P.	lb.	2.75	2.95
Benzyl chloride	lb.	2.45	2.50
Beta naphthol benzoate	lb.	10.00	12.00
Beta naphthol, sublimed	lb.	75	85
Beta naphthylamine, sublimed	lb.	2.65	
Dichlorobenzol	lb.	15	20
Dinitrobenzidine	lb.	4.00	4.50
Dinitrochlorobenzol	lb.	36	40
Dinitronaphthalene	lb.	40	45
Dinitrotoluol	lb.	55	60
Dinitrophenol	lb.	65	75
Dinitrophenol	lb.	55	60
D-methylaniline	lb.	74	76
Diphenylamine	lb.	1.00	1.10
II acid	lb.	3.25	3.50
Metachlorobenzidine	lb.	1.75	2.05
Monochlorobenzol	lb.	17	20
Naphthalene, flake	lb.	09	09 1/2
Naphthalene, balls	lb.	11	12
Naphthionic acid, crude	lb.	1.20	1.30
Naphthylamine di sulphonic acid	lb.	1.00	1.10
Nitro naphthalene	lb.	45	50
Nitro toluol	lb.	55	60
Ortho-amidophenol	lb.		
Ortho-dichlorobenzol	lb.	15	20
Ortho-toluidine	lb.	1.00	1.10
Ortho-nitro-toluidine	lb.	75	85
Para-amidophenol, base	lb.	4.00	4.50
Para-amido-phenol, H. Cl.	lb.	4.25	5.00
Para-dichlorobenzol	lb.	15	20
Paranitraniline	lb.	1.80	1.95
Para-nitro-toluidine	lb.	1.50	1.60
Paranitrobenzidine	lb.	4.00	4.50
Para-toluidine	lb.	2.00	2.25
Phthalic acid anhydride	lb.	4.00	4.50
Phenol, U. S. P.	lb.	42	45
Resorcin, technical	lb.	4.50	5.00
Resorcin, pure	lb.	7.50	8.00
S. lilylic acid	lb.	85	95
Solid	lb.	1.50	2.00
Sulphanilic acid, crude	lb.	31	33
Tolidin	lb.	2.50	3.00
Toluidine-mixture	lb.	85	90

Petroleum Oils

Crude (at the Wells)

Pennsylvania	bbl.	4.00	
Corning, Ohio	bbl.	2.85	
Summit, Ky.	bbl.	2.60	
Waco, Ohio	bbl.	2.68	
Indiana	bbl.	2.28	
Illinois	bbl.	2.42	
Oklahoma and Kansas	bbl.	2.25	
Caddo, La., light	bbl.	2.25	
Corviana, Tex., light	bbl.	2.25	
California	bbl.	1.24	1.57
Gulf Coast	bbl.	1.35	
Mexico	bbl.	1.90	

Fuel Oil

New York	gal.	15	
Philadelphia	gal.	10 1/2	
Pittsburgh	gal.	07 1/2	15
Pittsburgh	gal.	07 1/2	18
Texas	bbl.	1.85	2.35
Los Angeles	bbl.	1.65	

Gasoline (Wholesale)

New York, motor	gal.	.24	—
Gas machine	gal.	.41	—
72-76 degrees	gal.	.33	—
70-72 degrees	gal.	.32	—
67-70 degrees	gal.	.30	—
Pittsburgh, motor	gal.	.25	—
Chicago, motor	gal.	.22	—
Oklahoma, motor	gal.	.21	—
San Francisco, motor	gal.	.20	—

Paraffine Waxes

Crude, 103 to 105 deg. m.pt.	lb.	.08	—
Crude, 118 to 120 deg. m.pt.	lb.	.09	—
Crude, 124 to 126 deg. m.pt.	lb.	.10	—
Refined, 120 deg. m.pt.	lb.	.13	—
Refined, 128 deg. m.pt.	lb.	.14	—
Refined, 135 deg. m.pt.	lb.	.16	—
Ozokerite, brown	lb.	.75	—
Ozokerite, green	lb.	.85	—

Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	.24	—
Cylinder, light	gal.	.45	—
Cylinder, dark	gal.	.39	—
Paraffine, high viscosity	gal.	.40	—
Paraffine, 903 sp. gr.	gal.	.36	—
Paraffine, 885 sp. gr.	gal.	.26	—

Flotation Oils

(Prices at New York unless otherwise stated)

Pine oil, crude, f. o. b. Florida	gal.	.44	—
Pine oil, steam-distilled, sp. gr. 0.925-0.940	gal.	.58	—
Pine oil, destructively distilled	gal.	.58	—
Pine-tar oil, sp. gr. 1.02-1.035	gal.	.35	—
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.42	—
Pine-tar oil, ref., light, sp. gr. 0.930, tank cars, f. o. b. works	gal.	.37	—
Pine-tar oil, ref., heavy, sp. gr. 1.025, tank cars, f. o. b. works	gal.	.28	—
Pine-tar oil, ref., thin, sp. gr. 1.060-1.080	gal.	.32	—
Turpentine, crude, sp. gr. 0.870-0.900	gal.	.45	—
Hardwood oil, f. o. b. Michigan, sp. gr. 0.960-0.990	gal.	.23	—
Hardwood oil, f. o. b. Michigan, sp. gr. 1.06-1.08	gal.	.23	—
Wood creosote, ref. f. o. b. Florida	gal.	.31	—

Naval Stores

Rosin A-E barrel	280 lb.	14.50	—
Rosin F-I	280 lb.	15.10	—
Rosin K-N	280 lb.	15.75	—
Rosin W-G-W	280 lb.	16.25	—
Spirits of turpentine	gal.	.67	—
Wood turpentine, steam distilled	gal.	.63	—
Wood turpentine, destructively distilled	gal.	.58	—
Pitch	200 bbl.	7.50	—
Tar, kiln dried	280 lb.	12.50	—
Retort tar	280 lb.	13.50	—
Rosin oil, first run	gal.	.74	—
Second run	gal.	.77	—
Third run	gal.	.82	—
Fourth run	gal.	.92	—

Vegetable Oils

Castor oil	lb.	.28	—
China wood oil	lb.	.29	—
Cocanut oil	lb.	.17	—
Corn oil	lb.	.18	—
Cottonseed oil, crude	lb.	.20	—
Linseed oil, raw, cars	gal.	1.84	—
Olive oil	gal.	4.25	—
Peanut oil, crude	lb.	.18	—
Soya bean oil, Manchuria	lb.	.16	—

Glues

Extra white	lb.	.36	—
Cabinet	lb.	.31	—
Brown foot stock	lb.	.18	—
Fish glue, 50-gal. barrels	gal.	1.00	—

Miscellaneous Materials

Barytes, floated, white, foreign	ton	38.00	—
Barytes, floated, white, domestic	ton	33.00	—
Beeswax, white, pure	lb.	.63	—
Beeswax, unbleached	lb.	.43	—
Blanc fixe	lb.	.05	—
Casolin	lb.	.17	—
Ceylon graphite	lb.	.07	—
Chalk, light, precipitated, English	lb.	.04	—
China clay, imported, lump	ton	20.00	—
China clay, domestic, lump	ton	13.00	—
Feldspar	ton	8.00	—
Fluor spar, gravel, f. o. b. mines	ton	68.00	—
Fluor spar, washed, powdered	ton	90.00	—
Fuller's earth, powdered	100 lb.	1.50	—
Japan wax	lb.	.27	—
Mexican graphite	ton	75.00	—
Madagascar graphite	lb.	.10	—
Orange shellac	lb.	.72	—
Pumice stone	lb.	.04	—
Red lead, dry, carload	100 lb.	1.14	—
Soapstone	ton	15.00	—
Stearic acid, 120 deg. m.pt.	lb.	.18	—
Stearic acid, 140 deg. m.pt.	lb.	.19	—
Talc, American, white	ton	20.00	—
White lead, dry	lb.	.09	—

Refractories, Etc.

(F. O. B. Works)

Chrome brick	net ton	175.00	—
Chrome cement	net ton	75.00	—
Clay brick, 1st quality fireclay	per 1000	50.00	—
Clay brick, second quality	per 1000	35.00	—
Magnesite, raw	ton	30.00	—
Magnesite, calcined, powdered	ton	50.00	—
Magnesite, dead burned	net ton	50.00	—
Magnesia brick, 9x4x2	net ton	110.00	—
Silica brick	per 1000	50.00	—

Ferroalloys

Ferrocobalt, 15-18 per cent, carload, f. o. b. Niagara Falls N. Y.	ton	200.00	—
Ferrocobalt	lb.	15.00	—
Ferrocobalt, per lb. of Cr	lb.	.30	—
Ferromanganese, domestic, 70 per cent basis	ton	250.00	—
Ferromanganese, English	ton	325.00	—
Spiegelisen (16-18%)	ton	75.00	—
Ferromolybdenum, per lb. of Mo	lb.	4.00	—
Ferrosilicon, 75 per cent, f. o. b. N. Y.	ton	180.00	—
Ferrosilicon, 50 per cent, carload, del., Pittsburgh	ton	160.00	—
Ferrosilicon, 50 per cent, contract	ton	160.00	—
Ferrotungsten, 75-85 per cent, f. o. b. Pittsburgh	lb.	2.35	—
Ferrotungsten, f. o. b. works, per lb. of U	lb.	7.50	—
Ferrotungsten, f. o. b. works	lb.	—	—

Ores and Semi-finished Products

Antimony ore, per unit	ton	1.50	—
Chrome ore, 45 per cent minimum, f. o. b. Cal. per unit	ton	1.40	—
Chrome ore, 43 per cent and over, New York, per unit	ton	1.20	—
Manganese ore, 48 per cent and over, per unit	ton	80.00	—
Manganese ore, chemical	ton	1.25	—
Molybdenite, per lb. of MoS ₂	lb.	25.50	—
Tungsten, Scheelite, per unit of WO ₃	ton	24.00	—
Tungsten, Wolframite, per unit of WO ₃	ton	3.25	—
Uranium oxide, 96%	lb.	10.50	—
Vanadium pentoxide, 99%	unit	.17	—
Pyrites, foreign	unit	.28	—
Pyrites, domestic	unit	.30	—

Plant Supplies

BUILDING MATERIALS

Common clay bricks	M	13.00	—
Hollow tile, 4 x 12 x 12	M	60.00	—
Hollow tile, 12 x 12 x 12	M	170.00	—
Lime	ton	16.50	—
Portland cement	bbl.	2.59	—
Single glass (82-lb.), 10 x 26-16 x 24	ton	21.00	—
Double glass (164 lb.), 10 x 26-16 x 29	ton	31.00	—
Yellow pine lumber	M	39.00	—
Fir lumber	M	38.00	—
Hemlock	M	24.50	—
Tarred felt (14-lb. sq.)	ton	68.00	—
Roofing pitch	ton	27.00	—
Asphalt coated roofing (35-55-lb. sq.)	sq.	1.60	—
State surfaced asphalt shingles	sq.	5.25	—
Corrugated galvanized iron	ton	109.00	—
Putty	100 lb.	6.75	—
Red oxide (Ppte. Copperas)	100 lb.	15.00	—
Native red oxide	100 lb.	3.25	—
Red metallic paint	100 lb.	1.20	—
White lead in oil	100 lb.	11.84	—
Zinc lead in oil	100 lb.	12.28	—
Zinc oxide (dry)	100 lb.	13.00	—
Zinc oxide—leaded	100 lb.	9.00	—
Yellow ochre	100 lb.	1.50	—
Ultra marine blue	100 lb.	14.00	—
Prussian blue	100 lb.	135.00	—
Chrome green	100 lb.	40.00	—
Paris green	100 lb.	43.00	—
Mineral black	100 lb.	1.75	—
Powdered bone black	100 lb.	5.50	—
Lampblack	100 lb.	15.00	—
Gas carbon	100 lb.	16.00	—
Mexican petroleum pitch	100 lb.	1.00	—
Gilsonite	100 lb.	2.00	—
Coal tar pitch	100 lb.	.40	—

STRUCTURAL IRON

Blue annealed sheet iron	ton	84.00	—
Black sheet iron	ton	96.00	—
Galvanized iron	ton	105.00	—
Tern plate, 8-lb. coating	ton	150.00	—
Tern plate, 15-lb. coating	ton	177.50	—
Tern plate, 25-lb. coating	ton	200.00	—
Tern plate, 40-lb. coating	ton	240.00	—
Tin plate, prime	ton	155.00	—
Tank plates	ton	65.00	—
Beams, channels, angles, T's, Z's	ton	60.00	—
Rivets	ton	88.00	—
Steel pipe, 1 to 3-inch	ton	51.00	—
Bar iron and steel	ton	60.00	—
Chain (1 inch proof coil)	ton	150.00	—
Nails, bolts, nuts, washers	ton	70.00	—
Tool steels, special alloys	ton	300.00	—
Bessemer pig iron	ton	37.25	—
Bessemer steel	ton	47.50	—
No. 2 foundry	ton	33.50	—
Steel billets (4 x 4)	ton	47.50	—

POWER HOUSE SUPPLIES

Steam packing, rubber duck	lb.	.99	—
Asbestos, high pressure	lb.	1.76	—
Asbestos, wired	lb.	1.30	—
Asbestos, graphited braid	lb.	1.21	—
Asbestos, wick	lb.	.75	—
Rubber sheet	lb.	.66	—
Cup grease	lb.	.07	—
Transmission grease	lb.	.07	—
Axle grease	lb.	.04	—
Gear grease	lb.	.04	—
Cotton waste	lb.	.08	—
Hose, underwriters, 2 1/2 in.	ft.	.75	—
Hose, air, 1 in.	ft.	.30	—

INDUSTRIAL NEWS

Plant Construction—Catalogs—New Publications

Construction and Operation

Arizona

KINGMAN.—The Standard Mineral Co. will build a 50-ton flotation mill in the Mainard Mining District. Estimated cost, \$40,000. Ray L. Connell, engineer.

Arkansas

MENA.—The Baby Ray Mining Co., Room 11, Turner Building, Tulsa, Okla., is in the market for a steam shovel, log washer, belts, lumber, concrete, roofing, pumps and pipe. Estimated cost, \$25,000.

ROGERS.—Mr. George Pollard and Dr. Frank Schuckles will build a concentration plant and smelter for platinum and are in the market for engine, boilers, motors, pipe, pump, sludge and slime tables, crushers, lumber, concrete, belts, conveyors, tracks, ore cans, ore cars, smelter machinery ovens, belts, lumber, steel slides and metal roofing. Estimated cost, \$80,000.

ZELLVILLE.—The Cowan-Banners Development Co. will build a 200-ton concentration plant, and is in the market for sludge and slime tables, crushers, air compressors, drills, ore cans, ore cars, belts, engine, boilers, lumber and concrete. Estimated cost, \$60,000.

Connecticut

STRATFORD.—The Raybester Co., 1427 Railroad Ave., Bridgeport, has awarded the contract for the erection of a one and one half story, 100 x 105 ft., brick and concrete factory, to J. R. Sheehan, 211 State St. Estimated cost, \$17,000.

Florida

FORT LAUDERDALE.—The city will install a water filtration plant. Address the Mayor.

JACKSONVILLE.—The Jacksonville Gas Co., Laura and Church St., received low bid for building a 2-story, steel gas plant, from H. Vesey, \$12,500.

MOORE HAVEN.—The Grass Fiber Paper Pulp Co., recently incorporated with \$150,000 capital, has leased 75,000 acres of saw-grass land and will build a plant to manufacture paper from saw-grass.

Illinois

CHICAGO.—The Union Stock Yards, 38 South Dearborn St., will build a 6-story, 32 x 70 ft. rear addition to its soap boiling building. J. H. Jillson, c/o owner, architect.

Indiana

GARY.—United States Government plans to purchase from 2000 to 3000 acres of land near here, on which to build an air nitrate plant.

Kansas

HAXTER SPRINGS.—The Miami Volunteer Mining Co. will build a 200-ton concentration plant and is in the market for sludge and slime tables, crushers, air compressors, conveyors, engine, boilers, lumber, roofing, etc. Estimated cost, \$65,000. J. L. Hawthorne, superintendent.

Louisiana

MONROE.—The city will build a filtration plant. Estimated cost, \$25,000. W. G. Kirkpatrick, Jackson, Miss., engineer.

Maryland

BALTIMORE.—The General Chemical Co., 1218-24 Munsey Building, has awarded the contract for the erection of a 3-story, 153 x 211.6 ft., concrete brick and steel chemical plant addition on Race and Winder St., to the Westinghouse, Church, Kerr & Co., 37 Wall St., New York City, N. Y. Estimated cost, \$155,000. J. M. Bellamy, manager.

BALTIMORE.—The Kennedy Foundry Co., Charles and Wells St., will build a concrete and brick addition to its plant, and is in the market for moulding machinery for the manufacture of mustard gas shells of semi-steel for the United States

Government. Total estimated cost, \$100,000.

HAGERSTOWN.—The Central Chemical Co., Thomas Building, has increased its capital stock from \$200,000 to \$600,000 and will build additions to its plant.

INDIAN HEAD.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., received low bids for an oxidation absorption building, from the De Kemp Construction Co., Dispatch Building, Union Hill, N. J., \$124,000; Austin Co., 1313 H. St., Washington, D. C., \$143,000; Chemical Construction Co., Tyron St., Charlotte, N. C., \$178,500.

Massachusetts

SPRINGFIELD.—The Hendee Manufacturing Co., 837 State St., has awarded the contract for the erection of a 1- and 2-story, 41 x 70 ft. boiler plant and a 60 x 87 ft. hardening room, reinforced concrete, brick and steel, to E. J. Pinney, 264 Main St. Estimated cost, \$37,000.

Michigan

GRAND RAPIDS.—The Imperial Chemical Co., Ann St., will extend and improve its plant to provide for increased capacity.

Missouri

GRANBY.—Heaton & Hodges, Neosho, will build a 500-ton concentration plant and is in the market for two crushers, six sludge and slime tables, conveyors, air compressors, lumber, concrete, motors, engine, belts, pipe, roofing, bins, scales, cables, jigs, ore cans, ore cars and drills. Estimated cost, \$100,000. W. Heaton, superintendent.

MACON.—The city will build a sewage disposal plant, including Imhoff tank, sludge bed and storm overflow, involving about 790 lin. ft. 18-in. sewer and straightening of creek channel. Frank L. W. Syndicate Building, St. Louis, Mo., engineer.

NEOSHO.—The Neosho Mining Co. will build a 150-ton concentration plant near Spurgeon, and is in the market for crushers, boilers, engines, pipe, air compressors, concrete, lumber, roofing, conveyors, belts and wire cables. Estimated cost, \$40,000. C. Bushner, superintendent.

ST. LOUIS.—The LaCade Gas Light Co., 11th and Olive St., has awarded the contract for the erection of a 1-story, 200 x 1200 ft. steel plant for the manufacture of munitions, to Austin Co., 16112 Euclid Ave., Cleveland, Ohio. Estimated cost, \$8,000,000. Noted Aug. 31.

ST. LOUIS.—The Pan Electric Manufacturing Co., 735 South 4th St., plans to build a 60 x 100 ft. administration building and laboratories. Estimated cost, \$50,000. W. C. Forder, in charge.

ST. LOUIS.—The R. & N. Kansas Line Mining Co., Joplin, will build a 250-ton jig and concentration plant, and is in the market for four hand jigs, crushers, bins, pipe, lumber, cement, roofing, drills, engine, boilers, air compressors, belts, conveyors, car, track, cans and sludge tables. Estimated cost, \$65,000. W. A. Meece, superintendent.

New Hampshire

NASHUA.—The Nashua Manufacturing Co. has awarded the contract for the erection of a 5-story, 80 x 227 ft. reinforced concrete dye house, to the Turner Construction Co., 244 Madison Ave., New York City, N. Y.

New Jersey

BLOOMFIELD.—The International Arms & Fuse Co., Grove St. and Bloomfield Ave., will build a 1-story, 20 x 190 ft. heat treating shop addition.

CAMDEN.—The Dobbins Soap Manufacturing Co., Federal St., will build an addition to its plant and make alterations and improvements to its existing works. Estimated cost, \$20,000.

CHROME.—The American Agriculture Chemical Co. has awarded the contract for the erection of a 2-story, 101 x 227 ft. reinforced concrete fertilizer plant at its Liebig Works here, to the Turner Construction Co., 244 Madison Ave., New York City, N. Y.

TRENTON.—The M. M. S. Metal Co., Fall St., will rebuild its plant recently damaged by fire, entailing a loss of \$25,000.

New York

BUFFALO.—The Metal & Alloy Specialty Co., 25 Illinois St., will build a 2-story, 60 x 100 ft. brick and steel factory at Marion Ave. and New York Central Railroad. Elmer Rae, manager.

CARTHAGE.—The National Paper Co., 126 Canal St., will build a 3-story, 60 x 200 ft. concrete and brick paper mill. Estimated cost, \$60,000.

ILION.—The Remington Arms Co. has awarded the contract for the erection of 2-story, 70 x 197 ft. dry kiln, to Richards & Co., 246 Elizabeth St., Utica. Estimated cost, \$35,000.

NEW YORK CITY.—The Goodyear Rubber Insulating Co., 105 East 131st St., will build a 2-story addition to its plant here.

OSWEGO.—The Hessler Foundry & Manufacturing Co., Mitchell St., will rebuild its plant which was recently destroyed by fire entailing a loss of \$100,000. The company manufactures brass and castings. G. J. Hessler, president.

PIERMONT.—The Piermont Paper Mills has awarded the contract for the erection of a 2-story, 100 x 250 ft. reinforced concrete factory, to Turner Construction Co., 244 Madison Ave., New York City, N. Y.

Ohio

AKRON.—The Kelly Springfield Tire Co., 229 West 57th St., New York City, N. Y., has awarded the contract for the erection of a 3-story, 42 x 130 ft. concrete, brick and steel rubber factory, to W. A. Franklin & Sons, 146 Howard St. Estimated cost, \$50,000.

CLEVELAND.—The National Carbon Co., West 117th St., has awarded the contract for the erection of six 1-story buildings, three 50 x 60 and three 60 x 80 ft. reinforced concrete, brick and steel, to the Hukin Conkey Co., Century Building. Estimated cost, \$100,000.

CLEVELAND.—The Ordnance Department, United States Government, Plymouth Building, Prospect and East 22nd St., will build a byproduct coke oven. Estimated cost, \$500,000.

KINGS MILLS.—The Peters Cartridge Co., 1700 First National Bank Building, Cincinnati, will build a 2-story, concrete brick and steel factory for the manufacture of munitions. Estimated cost, \$50,000.

LORAIN.—The Union Chemical Co., Union Building, Cleveland, has awarded the contract for the erection of eighteen, 1- and 2-story, reinforced-concrete, brick and steel chemical plants, to J. Hott & Co., 1340 Chestnut St., Philadelphia, Penn. Estimated cost, \$1,500,000.

MIDDLETOWN.—The Paul Sorg Paper Co. has awarded the contract for the erection of a 2-story, 25 x 288 ft. brick, steel and reinforced-concrete paper mill, to Caldwell & Iseninger, 5th St. Estimated cost, \$60,000.

ARDMORE.—The Choctaw Refining Co., Carter Building, will build an oil refinery for the production of lubricating oil and wax, and will install oil refinery equipment etc. R. W. Wallace engineer.

Oklahoma

DOUTHAT.—The Guening Mining Co. will build a 250-ton concentration plant and is in the market for sludge and slime tables, crushers, conveyors, motors, lumber, roofing, concrete, engine, boilers, air compressors and wiring for electric lights. Estimated cost, \$63,000. J. Pulver, superintendent.

DUNCAN.—The city will build sewage disposal plant. Estimated cost, \$30,000.

KANSAS.—The Defenders Mining Co., Joplin, Mo., will build a 200-ton concentration plant and is in the market for crushers, sludge and slime tables, belts, cables, engine, boilers, air compressors, conveyors, lumber, concrete, ore cans and ore cars. Estimated cost, \$65,000. J. H. Wright superintendent.

LINCOLNVILLE.—The Lucky Pat Mining Co., Miami, will build a 200-ton concentration plant near here and is in the market for jigs, crushers, rolls, drills, air compressors, lumber, conveyors, engine, boilers, roofing, pumps, and sludge and slime tables. Estimated cost, \$65,000. J. Screvner, superintendent.

LINCOLNVILLE.—The Neil Mining Co. will build a 400-ton concentration plant, and is in the market for lumber, roofing, crushers, slime and sludge tables, engine, boilers, motors, belts, drills, ore cans, ore car, wire cables. Estimated cost, \$10,000.

LOUISVILLE.—The Hercules Development Co., Miami, will increase the capacity of its concentration plant to 400 tons and is in the market for lumber, roofing, sludge and slime tables, motors, wiring pipe, engine, boilers, concrete, jigs, ore cans, ore cars and track. Estimated cost, \$75,000. Carl Carmen, superintendent.

MIAMI.—The Blue Bonnet Mining Co. will remodel its 250-ton concentration plant and is in the market for 40 h.p. electric motor, hoppers, lumber, concrete, sludge tables, etc. Estimated cost, \$25,000. C. V. Wright, superintendent.

MIAMI.—The DeArman Mining Co. will remodel its 250-ton concentration plant and is in the market for two seven-shaft channers, five sludge and slime tables, sand jig, crushers and lumber. Estimated cost \$25,000.

MIAMI.—The Lenabee Co., Coffeyville, Kan., will build a 250-ton concentration plant and is in the market for sludge and slime tables, crushers, air compressors, drills, roofing, lumber, conveyors, pipe, engine, boilers, track, cans, wire cables, and concrete. Estimated cost, \$65,000. J. R. McCorkle, superintendent, in charge.

MIAMI.—The Lucky Jem Mining Co. will build a 200-ton concentration plant and is in the market for sludge and slime tables, motors, crushers, air compressors, drills, lumber, roofing, pipe, boilers, engine, etc. Estimated cost, \$65,000. W. C. Booman, superintendent.

MIAMI.—The St. Louis Lead & Zinc Co. will build a 200-ton concentration plant and is in the market for crushers, bks, wire cables, sludge and slime tables, motors, engine, boilers, pipe, lumber, roofing, pumps, concrete, air compressors, track, cars, etc. Estimated cost, \$65,000. George Lumick, superintendent.

PICHER.—The Climax Mining Co. will build a 150-ton concentration plant and is in the market for sludge and slime tables, engine, boilers, motors, belts, crushers, roofing, lumber, concrete, air compressors, bins, hoppers, track and cars. Estimated cost, \$60,000. Grant Mans, superintendent.

PICHER.—C. F. Dike, Joplin, Mo., will build a 250-ton concentration plant and is in the market for jigs, sludge and slime tables, crushers, conveyors, tracks, motors, ore cars, ore cans, belts, electric wiring, lumber, roofing and mill hardware. Estimated cost, \$65,000.

PICHER.—The Grace Walker Mining Co., Baxter Springs, Kan., will build a 250-ton concentration plant to replace one recently destroyed by fire and is in the market for sludge and slime tables, crushers, boilers, roofing, new lumber, engine, motor, air compressors, drills, conveyors and concrete. Estimated cost, \$65,000.

PICHER.—The McCurdy Mining Co. will build a 250-ton concentration plant and is in the market for sludge and slime tables, crushers, pipe and air compressors. Estimated cost, \$10,000. D. McCurdy, superintendent.

QUAPAW.—The Big V Mining Co. will remodel and complete its 250-ton concentration plant near Lincolnville, and is in the market for sludge and slime tables, ore cans, ore cars, tracks, crushers, pipe, air compressors, conveyors and drills. Estimated cost, \$40,000. C. S. Voorhees, superintendent.

SAINT LOUIS.—The King-Brand Mining Co., Jefferson City, Mo., will build a 300-ton concentration plant and is in the market for sludge tables, crushers, motors, drills, lumber, air compressors, conveyors, roofing, concrete engine and boiler. Estimated cost, \$45,000.

SAPULPA.—The Prime Petroleum Co., Tulsa, will build an absorption gasoline plant to have a daily capacity of 400 gallons. Estimated cost, \$135,000. Glen R. Smith, general manager.

Pennsylvania

ALLENTOWN.—The Trojan Powder Co., 800 Hunsicker Building, has awarded the contract for the erection of a 1-story, 40 x 60 ft. powder plant to Rutz & Clader, 530 Hamilton St. Estimated cost, \$200,000.

BRIDGEC.—The Monongahela Melting Co. will reconstruct its furnace building at 6th St. and Monongahela River, recently destroyed by fire, entailing a loss of \$25,000.

ERE.—The Superior Bronze Co., 520 West 19th St. will build a four-day on West 19th St. and install equipment enabling the company to handle heavy aluminum castings. Estimated cost, \$15,000. W. H. Dunn, vice president and secretary.

PAIMERTON.—The New Jersey Zinc Co., 45 Wall St., New York City, N. Y., has awarded the contract for the erection of a three-story, 69 x 130 ft. laboratory,

here, to Hugh M. Krumbharr, 68 William St., New York City, N. Y. Estimated cost, \$200,000.

PHILADELPHIA.—The Charles Eneu Johnson & Co., 509 South 10th St., will build a one-story, 60 x 120 ft., brick and concrete factory addition for the manufacture of printing ink. Estimated cost, \$25,000.

PHILADELPHIA.—The Logan Iron & Steel Co., Morris Building, has increased its capital stock from \$240,000 to \$480,000, and will build additions to its plant.

PHILADELPHIA.—The Polyclinic Hospital, 1720 Lombard St., will make alterations and additions to its laboratory. J. Ethan Fieldstein, architect.

PHILADELPHIA.—The Super Glass Co., 3400 Dikson St., will build several additions to its plant in the Wisconsin Section for the manufacture of lenses for gas masks.

POTTSTOWN.—The McClintic Marshall Construction Co., 1200 Oliver Building, Pittsburgh, has awarded the contract for the erection of a one-story, 390 x 594 ft. steel fabricating shop, to Hughes Foulkrod, Oliver Building, Pittsburgh. Estimated cost, \$500,000.

Rhode Island

HILLGROVE.—The Rhode Island Malleable Works has awarded the contract for the reconstruction of its annealing buildings, recently destroyed by fire to C. E. Carlson, 68 Congress Ave., Providence. Estimated cost, \$55,000.

WOONSOCKET.—The Star Carbonizing Co., Diamond Hill Rd., has awarded the contract for the construction of a two-story, 52 x 178 ft. brick factory, to W. Aubin, 1103 Diamond Hill Rd. Estimated cost, \$45,000. Noted Sept. 15.

South Dakota

HILL CITY.—The American Tin & Tungsten Co. will install a 250-ton reground system and slime plant at its mine here. R. A. Meyer, general manager.

Texas

HOUSTON.—The Humble Oil and Refining Co., 1602 Carter Bldg., will build a refinery to have a capacity of 2000 barrels.

SAN ANGELO.—The San Angelo Water, Light & Power Co. will build a modern filtration plant. Estimated cost, \$35,000.

WACO.—The Water Works Commission will build a 90 x 280 ft. settling basin at the filtration plant at Vermont and 3rd Sts., to have a capacity of 5,000,000 gallons. Estimated cost, \$25,511. E. L. Fulkerson, secretary manager water works, N. Wrenskold, Dallas, will prepare plans and specifications.

Washington

SEATTLE.—The Air Reduction Co., 3623 East Marginal Way, has awarded the contract for the erection of a one-story, 41 x 172 ft. factory for the manufacture of oxygen and nitrogen cutting and welding supplies to the Black Masonry & Construction Co., Alaska Building. Estimated cost, \$30,000.

SEATTLE.—W. L. Harris has purchased the plant of the Olson-Klopf Welding & Cutting Co., 74 West Jackson St., and will equip same for the manufacture of hydrogen and oxygen.

Ontario

CRAIGMONT.—The Conigas Mines, Ltd., will build a plant for the retreatment of feldspar tailings and is in the market for crushing machinery, power machinery, transmission equipment, etc. F. D. Reid, Cobalt, engineer.

ELMIRA.—The Elmira Rubber Co. has awarded the contract for the erection of an addition to its factory, to Dunker Brothers, c/o A. J. Copeland, architect, c/o Dominion Tire Co. Estimated cost, \$30,000. Noted Sept. 15.

TORONTO.—The British Acetones, Ltd., Trinity St. will build an addition to its plant on Mill St. Estimated cost, \$4000.

TORONTO.—The Ontario Fertilizer Co., Smer Road, will build an addition to its plant. Estimated cost, \$10,000.

WINDSOR.—The Town Council will vote on January 1, 1919 for the construction of a water filtration system. Estimated cost, \$300,000. F. M. Brann, engineer.

Quebec

LACUNE.—The Munitions & Machinery, Ltd. has awarded the contract for the erection of an addition to its shell factory, to Anglin, Ltd., 85 Victoria Ave., Montreal. Estimated cost, \$25,000.

MONTREAL.—The Canada Cement Co. will build an addition to its plant. Esti-

mated cost, \$1,000,000. A Government contract of \$10,000,000 for shells has made this necessary.

MONTREAL.—The Canadian Consolidated Rubber Co., 201 Inspector St., will build a seven-story, reinforced concrete and steel factory. Estimated cost, \$60,000.

SHAWINIGAN FALLS.—The Canadian Ferro Alloys Co. has awarded the contract for the erection of an addition to its factory, to G. A. Gruninger, 155 Lavolette

Industrial Notes

THE LAKEWOOD ENGINEERING COMPANY, Cleveland, Ohio, announce the appointment of Mr. Payne G. West as assistant manager of field sales. This company also announces the opening of new offices in Chicago in the Lumber Exchange Building.

THE GENERAL ELECTRIC COMPANY will have space at the Allied Metals Congress to be held the week of Oct. 7 at the Milwaukee Auditorium. Enlarged pictures will be used to show G-E apparatus and lantern slides to illustrate foundry applications of this company's products. No machinery will be shown. Mr. L. W. Shugg is in charge of the exhibit.

THE PNEUMATOR COMPANY, INC., has moved from 15 Liberty Street, New York City, to larger quarters in the Park Row Building, 15 Park Row.

THE CHAS. T. TOPPING MACHINERY COMPANY has merged its interests with the Pittsburgh Office of the Lakewood Engineering Company, Cleveland, Ohio, manufacturers of construction plant and industrial haulage. Their office is at 411 Fulton Building.

THE WILL CORPORATION announces that eighty per cent of its members have gone into active war service and the Board of Directors have decided to immediately discontinue the corporation. In order to fully protect the interests of clients, to carry forward the work now in progress, and to place records and research material in available form, arrangements have been made with Dr. Victor J. Chambers, Director of the Department of Chemistry, University of Rochester, Rochester, N. Y., to continue the service rendered in the past. This company feels that all problems entrusted to Dr. Chambers will have his careful attention and consideration, as many of the practical results obtained in the past have been made possible through his counsel and aid.

THE JEFFREY MANUFACTURING COMPANY, Columbus, Ohio, announce the re-opening of the Cleveland branch office at 437 Leader-News Building, which will be in charge of Messrs. P. C. Dierdorff and C. B. Reed.

THE FRANKLIN INSTITUTE has awarded the John Scott Medal to Mr. Conrad Dressler, of the American Dresser Tunnel Kilns, Inc., 171 Madison Ave., New York, in recognition of his contribution to the advancement of the science of firing (furnaces for annealing, etc.).

MESSRS. W. CANNING & Co., electroplaters, engineers & manufacturing chemists whose Snow Hill Engineering Works at Birmingham, England, were totally destroyed by fire on August 23rd, have purchased extensive premises and machinery, as a going concern, at Salop Street, Highgate, Birmingham, formerly in the occupation of Piston Rines, Ltd., having found it impossible to rebuild the engineering works without delay. Work has already been resumed.

THE AMERICAN METALLURGICAL CORPORATION, Franklin Trust Building, Philadelphia, has just been awarded a contract by the Aircraft Division for the installation of special heat treatment equipment at the plant of the Ohio Seamless Tube Company, Shelby, Ohio. The installation is in connection with the heat-treatment of airplane tubes and it is hoped that the efficiency of the tubes will be increased to such an extent that a large amount of weight will be saved in the planes, allowing for the general increase of efficiency throughout. The heating units are to be supplied by the General Electric Company under the direction of Mr. Collins, Chief of the Industrial Heating Division.

THE SOUTH-HALL COMPANY, Chicago, electric furnace builders and metallurgists, have moved their sales and administrative offices from 585 West Washington Boulevard to 2309 Archer Avenue, where only the engineering and construction departments have hitherto been located. By this change all departments of the business are combined and the furnaces in course of construction are at all times under the inspection of the officials of the company.